AN EXAMINATION
OF ALTERNATIVE SOURCES OF ENERGY
FOR DESCHAMBAULT LAKE, SASKATCHEWAN

AN EXAMINATION OF ALTERNATIVE SOURCES OF ENERGY FOR DESCHAMBAULT LAKE, SASKATCHEWAN

Prepared for:

Deschambault Lake Hamlet Council

Prepared by:

Bell & Associates
Monenco Limited

Funded by:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada

RCDP/PDCE-21

April 1984

This report was prepared with a contribution from the Remote Community Demonstration Program of Energy, Mines and Resources Canada (EMR). Distribution of this report by EMR does not necessarily signify that the contents reflect the views and policies of EMR. Mention of trade names and commercial products does not constitute recommendation or endorsement for use.

TABLE OF CONTENTS

	PAGE
Abbreviations used in report	ix
Letter of transmittal	xi
Abstract	xiv
Résumé	xv
INTRODUCTION	1
ENERGY PROFILE OF DESCHAMBAULT LAKE	4
Total Energy Consumption All Sources - 1931/82	4
Electrical Energy Costs	4
Diesel-Electric Power Costs	4
Residential Energy Costs	8
Diesel-Generated Schedule of Rates	15
Residential	15
Commercial	15
Government	15
Provincial Grid Rates	16
SOCIO ECONOMIC CONSIDERATIONS	18
Introduction	18
Residential Survey	18
Resource Ownership	22
Anticipated Energy Demand	22
Population Growth	22
Development Plans With:	
Potential Impact on Community Population and Energy Demand to 1995	24
Other Factors Impacting on Energy Demand to 1995	25

PAGE

Electrical Energy Demand - 1995 27

WOOD AND PEAT RESOURCES - DEVELOPMENT PLANS 31

Deschambault Fuelwood Analysis 31

Wood Volumes 31

Access 32

Forest Regulations 33

Other Resource Uses 35

Resources Ownership 35

Fuelwood Harvesting Costs 35

Peat Resources 38

Field Work 38

Summary of Preliminary Peat Resource Investigation 45

Peat Mining - Development Plans 45

Mining Criteria 45

Resource Potential of the Peatland 46

Mining Requirements 46

Conceptual Mine Planning (Small-Scale Operation) 47

Climatic Analysis 47

Frost Free Period 49

Sunshine 49

Average Temperatures 49

Precipitation 49

Potential Evapotranspiration 49

Key Mine Planning Assumption 50

Selection of Mining Area 52

Mining Cost Estimate 53

Transportation Costs 53

PAGE

ENERGY OPTIONS 67
Grid Extension to Deschambault Lake 67
Mini-Hydro Option for Deschambault Lake 68
EMR Preliminary Assessment 68
Monenco Review 70
Possible Peat Utilization Scheme 71
Introduction
Peat-Fired Generation Station to Meet Current Demand 73
Description of the Plant 74
Peat Receiving and Handling Equipment 75
Peat-Fired Boiler and Auxiliaries 75
Steam Engine/Generator Set 76
Design and Operating Criteria 77
Cost Estimates 77
Other Considerations 78
Costs of Peat-Fired Power Generator 79
250 KW Plant Size 79
500 KW Plant Size 79
Some Socio-Economic Benefits of a Peat-Fired Facility 81
Other Peat-Fueled Technology 82
DISCUSSION OF ENERGY ALTERNATIVES 84
SUMMARY AND CONCLUSIONS 87

APPENDICES

APPENDIX I - Manufacturers' Information 92
APPENDIX II - Bibliography 108

LIST OF TABLES

TABLE		PAGE
2-1	Energy Profile: Source Fuel Consumption for Deschambault Lake - 1981	5
2-2	Energy Profile: Annual Energy Consumption for Deschambault Lake - 1981	6
2-3	Diesel Electric Power Generation Costs - Deschambault Lake, Saskatchewan	7
2-4	Survey of Annual Residential Fuel Costs - Deschambault Lake	9
2-5	Consumer Energy Costs on an Annual Basis Averaged Overall Residential Consumers (1982-1983)	13
2-6	(A) Electical Service Charges - Deschambault Residential (Dec. 12, 1982 to Jan. 12, 1983 - One Month)	13
2-6	(B) Electrical Service Charges - Residential Meter Readings (Dec. 12, 1983 to Jan. 12, 1984 - One Month)	14
2-7	Average Temperatures - La Ronge, Sask.	14
3-1	Residential Survey Results	19
3-2	Deschambault Lake Population Statistics	23
3-3	Anticipated Electrical Consumption by 1995 (Bell et al)	29
3-4	Anticipated Electrical Demand by 1995 (North Sask. Electric)	30

TABLES (Cont'd)

TABLE		PAGE
4-1	Sample Harvesting Costs by Work Items (Coban Study)	37
4-2	Comparison of Climatic Data	48
4-3	Initial Pre-Production Equipment List and Rental Cost Estimate	55
4-4	Pre-Production Labour Costs	56
4-5	Production Equipment List and Capital Costs	57
4-6	Annual Operating Cost Estimate	58
4-7	Estimated Capital Costs of Service Facilities	60

LIST OF FIGURES

FIGURE		PAGE
2-1	Desc[illegible]bault Lake	17
4-1	Deschambault Lake Peat Study Fuelwood Analysis	61
4-2	Deschambault Lake Peat Study Peat Deposit Location Map	62
4-3	Deschambault Lake Peat Study, Bog No. 6 - Survey Line Location	63
4-4	Deschambault Lake Peat Study, Bog No. 7 - Survey Line Location	64
4-5	Deschambault Lake Peat Study Conceptual Drainage and Mine Plan	65
4-6	Deschambault Lake Peat Project - Project Development Schedule	66
5-1	Typical Schematic Peat-Fired Boiler/Steam Engine Generator Set	83

LIST OF ABBREVIATIONS USED IN THIS REPORT

1. AAC - Annual Allowable Cut
2. Ag - gross mineable area requirement
3. An - net mining area requirement
4. B.E.I. - trees, shrubs, moss
5. B.T.U. - British Thermal Unit
6. cfs - cubic feet per second
7. cm - Centimetre
8. C.M.H.C. - Central Mortgage and Housing Corporation
9. cv - calorific value
10. ^{o}c - degrees Centigrade
11. dbh - diameter, breast, height
12. D.I.A.N.D. - Department of Indian Affairs and Northern Development
13. D.N.S. - Department of Northern Saskatchewan
14. E.I. - shrubs, moss
15. G - harvesting yield/hectare/season
16. g - harvesting yield/cycle/hectare
17. GJ - Siga Joule
18. H - stream head in feet
19. ha - hectare
20. H.B.M. & S. - Hudson Bay Mining and Smelting Ltd.
21. km - Kilometre
22. kPa - Kilopascal
23. KW - Kilo Watt
24. KWH - Kilowatt hour
25. Lb - Pound

26. m - Metre

27. mm - Millimetre

28. m^3 - Cubic metre

29. mc - moisture content

30. odt - oven dried ton

31. O & M - Operation and Maintenance

32. ppm - part per million

33. Q - stream flow rate

34. S.H.C. - Saskatchewan Housing Corporation

35. tA - trembling aspen

36. VPH - Von Poat Humification

37. WB - White Birch

MONENCO LIMITED

COLONIA PLACE
2 St. Clair Avenue E., Toronto, Ontario M4T 2T5
Tel.: (416) 961-4580
Telex: 06-22613
Cables: Monencon

17 April 1984
File Ref: BAA 8034-5

The Local Advisory Council
General Delivery
Deschambault Lake, Saskatchewan

Attention: Mr. Oscar Beatty, Chairperson

Dear Mr. Beatty:

Re: An Evaluation of Alternative Sources of Energy

We are pleased to submit our report entitled "An Evaluation of Alternative Sources of Energy for Deschambault Lake, Saskatchewan" for your consideration. This has been an interesting assignment and we are encouraged by the possibilities of several alternative sources to improve the energy situation at Deschambault Lake. The mandate for the current study was considerably reduced over its original intent due to availability of funding and it has not been possible to select a "best" alternative.

The study has answered, at the preliminary level, some of the basic questions, e.g., it appears an adequate peat resource exists in the area, and that conventional peat harvesting can be carried out to yield a fuel peat product suitable for burning, and that electrical power can be generated at the small scale (less than 1-5MW) using steam engine technology. However, several more questions have been raised, e.g., is there a possibility for mini-hydro (200-400 kW) since indications of a potential site do exist? Is a combination of peat-firing as a base load (due to the turn-down characteristics of peat-fired equipment) with diesel generators for peaking (or possibly mini-hydro) a possible option?

Although peat-firing and steam engines are not new, the application to power generation appears to be unique and requires further examination for the specific needs of Deschambault. The possibilities of waste heat recovery from a peat-fired steam engine facility appear practical, but the technical aspects (and costs) need to be examined in further detail along with the possible uses of the heat energy (e.g. greenhouse heating, hot water supply for various uses).

Mr. O. Beatty

Other questions which have arisen and require resolution are: Is the grid "reinforcement" line planned for the eastern side of Saskatchewan a real possibility, and what would be the influence of a decision by Deschambault to generate power locally on the line's location (or construction)? It appears that if a connection to the provincial grid is forseeable, coupled with the application of standard provincial rates for the community (i.e. considerably less than the current "disincentive" rates) that the costs of such a connection will be rather immaterial from the village's perspective (although not from the provincial perspective) since the prime concern currently is to reduce electricity rates. Before other generation alternatives can be compared on an equal basis, it will have to be assumed that the costs of all alternatives, including grid power, must be recovered in the rate structure or, alternatively, that the provincial rate structure be applied to Deschambault Lake regardless of the option chosen. The preferred energy option should then be selected for the various technical reasons (adequacy of supply, reliability, etc.), costs and other social and economic factors affecting the community. It is considered that a preliminary economic analysis of the alternatives should include all costs, in order to determine the most efficient means of providing power to the community.

It is recommended that the current study be continued into a second phase to provide answers to the above questions and others raised in the report. It should be the objective of the second phase of study to clearly identify an optimum power generation alternative for Deschambault. A peat-fired facility has some strong socio-economic benefits in terms of local industry and employment which should be pursued. However, the questions of grid connection, mini-hydro, rate structure, etc. need to be addressed at the initial stage of the following investigation.

Mr. O. Beatty

We are pleased to have carried out the work on your behalf and trust that you find the report interesting and deals directly with the issues affecting Deschambault Lake. We would be pleased to assist you further at your request.

Yours very truly,

G. W. Mankinen,
Manager, Peat Group
Mining Division

J. Bell
Bell & Associates

GWM/lmm
Encl.

ABSTRACT

This report describes the findings of a study of electrical energy consumption and alternative electrical energy sources for the community of Deschambault Lake, Saskatchewan.

The study finds that a growing number of residential consumers are required to expend a significantly higher portion of their income on electricity than residents of the rest of the province. Also, at the present rate of demand growth, the current deisel generating facility will shortly be inadequate to meet local demand.

Some preliminary recommendations are made on alternative methods by which the public utility company might resolve the "adequacy of supply" problems. The ultimate selection of the "best option" will require additional cost analysis, and definitive information on the near term practicality of connecting the village to the provincial grid network.

From the community perspective, the best option would appear to be the utilization of local peat or peat/wood resources for electrical power generation, in view of the significant socio-ecomonic benefits that would accrue from this alternative.

UNE ETUDE DES SOURCES D'ENERGIE DE RECHANGE

POUR DESCHAMBAULT LAKE (SASKATCHEWAN)

Résumé

Le présent rapport fait état des résultats d'une étude qui a été effectuée au sujet de la consommation électrique et des ressources d'énergie de rechange pour la communauté de Deschambault Lake en Saskatchewan.

L'étude révèle qu'un nombre croissant de clients résidentiels doivent consacrer une part beaucoup plus élevée de leur revenu pour l'électricité que les résidents de la province raccordés au réseau provincial. De plus, au taux d'augmentation actuel de la demande, la centrale diesel existante ne sera plus en mesure de satisfaire à la demande des résidents de la localité dans un avenir rapproché.

Le rapport fait quelques recommandations préliminaires sur des méthodes qui pourraient permettre à l'entreprise de service d'utilité publique de résoudre les problèmes ayant trait à "la suffisance des sources d'énergie". La sélection finale de la meilleure option énergétique nécessitera des analyses additionnelles des coûts ainsi que de l'information définitive sur la nature pratique à court terme de relier le village au réseau provincial d'électricité.

Selon la communauté, la meilleure option semblerait être l'utilisation de la tourbe locale ou des ressources locales de la tourbe et du bois pour la production d'électricité. Des bénéfices socio-économiques significatifs proviendraient de cette option.

Les principales conclusions d'une façon plus détaillée sont les suivantes:

1. Le coût élevé de l'énergie préoccupe les résidents de la localité; le nombre des ménages touchés par le problème augmente partiellement, parce que les normes des nouvelles maisons construites depuis 1980 entraînent une consommation plus élevée d'énergie.

2. La structure actuelle des tarifs à Deschambault Lake comprend pour la tranche de consommation jusqu'à 315 kW.h/mois des tarifs comparables à ceux que payent les clients raccordés au réseau provincial. Cependant, au-delà de ce plafond, les tarifs augmentent rapidement pour décourager la consommation d'électricité, à cause de la capacité de production limitée.

3. Bell et ses collaborateurs ont fait une analyse de la demande d'énergie par la collectivité de Deschambault Lake d'ici 1995, et ont utilisé des données supplémentaires fournies par la North Saskatchewan Electric. Selon leur analyse, la consommation, qui était d'environ 900 000 kW.h en 1982, atteindrait 2 millions de kilowatts-heures par an à cause de facteurs "normaux" tels que la croissance démographique, la construction de nouvelles maisons, les besoins de l'industrie légère, etc. Compte tenu de la croissance du stock d'habitations, de l'augmentation de la charge commerciale et de l'effet important entraîné par un passage à la structure des tarifs ordinaires appliqués dans la province, la consommation d'électricité atteindrait 4,2 millions de kilowatts-heures par an d'ici 1995 (estimation de la North Saskatchewan Electric).

   Il est évident que la capacité de la centrale diesel actuelle sera bientôt insuffisante.

4. Un examen préliminaire des ressources locales en bois indique qu'il y aurait assez de bois dans un rayon raisonnable du village pour alimenter une centrale électrique. L'expert-conseil a déterminé les coûts de la récolte très approximativement; ils se situeraient dans la gamme d'environ 22 $ la tonne anhydre dans le cas d'une exploitation totalement mécanisée et jusqu'à environ 100 $ la tonne anhydre dans le cas d'une exploitation à la scie et par débusquage.

5. Un relevé sommaire des tourbières de la région qui comprenait la visite de huit sites a été effectué. Une tourbière (n° 6) est de 2 000 ha, dont environ 1 000 ha ont une profondeur moyenne supérieure à 1,5 m. Le volume exploitable du gisement s'élèverait à quelque 1,7 million de tonnes, séché à l'air à une teneur en eau de 35%. Le pouvoir calorifique d'un échantillon prélevé de ce gisement était de 8 740 Btu/lb (teneur en eau: 0%), pour une qualité ordinaire de combustible-tourbe.

6. Le climat semblerait permettre l'extraction de la tourbe par des méthodes classiques à Deschambault Lake. Il faut entreprendre des études additionnelles des facteurs météorologiques pour évaluer avec plus d'exactitude les volumes en tonnes de combustible-tourbe séché à l'air. Selon les indices, on pourrait compter sur au moins un cycle d'extraction et peut-être deux par année.

7. Les coûts d'extraction de la tourbe seraient quelque peu plus élevés qu'au sud; les chiffres présentés traduisent aussi une certaine prudence quant aux volumes d'extraction. Pour un rythme d'extraction de 5 100 tonnes par an, le coût s'élèverait à environ 52 $/t de tourbe livrée à la centrale. Le coût diminue sensiblement avec une augmentation de l'échelle d'exploitation et serait d'environ 35 $/t pour une exploitation de 10 000 t/an.

8. L'étude examine plusieurs options énergétiques, y compris:
   - le prolongement du réseau à Deschambault Lake,
   - une mini-centrale hydro-électrique, et
   - différentes installations alimentées au bois et à la tourbe.

On examine plusieurs hypothèses par rapport au prolongement du réseau, y compris celle où les résidents de Deschambault Lake paieraient des tarifs provinciaux normaux et où les coûts de construction de la ligne de transport seraient supportés par le reste du réseau ou payés par la province. On examine aussi le cas d'une récupération des coûts de construction par l'imposition de tarifs spéciaux aux consommateurs de Deschambault Lake. Ces décisions entraînent des effets importants pour l'analyse des autres options. La solution à la question du prolongement du réseau dépasse la portée de l'étude actuelle, mais s'imposerait lors de l'étape initiale d'aucune phase suivante.

En ce qui concerne une mini-centrale hydro-électrique, la Monenco a examiné très sommairement les cartes topographiques de la région et a repéré un site qui se prêterait à l'aménagement d'une mini-centrale hydro-électrique de 200 à 400 kW (sans qu'il soit nécessaire de contrôler le débouché actuel du lac), dans l'hypothèse d'une fluctuation de 18 pouces environ du niveau du lac. Il faudrait examiner cette option lors des premières étapes d'une étude technique plus détaillée. Une combinaison d'une centrale alimentée à la tourbe et d'une mini-centrale hydro-électrique pour les pointes pourrait s'avérer une option intéressante, notamment pour satisfaire à la demande future.

On a choisi une machine à vapeur alimentée à la tourbe et un générateur comme l'option éventuelle qui conviendrait pour produire de l'électricité à Deschambault Lake, étant donné l'échelle réduite. Une installation de 250 kW répondrait à la demande actuelle d'électricité (en raison aussi des caractéristiques de faible charge de l'installation alimentée à la tourbe). Elle servirait aussi à illustrer la technique et les coûts. L'efficacité globale du système est plutôt faible, mais la technique est relativement simple et a servi pour d'autres fins. Il faudrait des travaux détaillés additionnels pour examiner la technique par rapport aux conditions qui règnent à Deschambault Lake. La capacité de 250 kW correspond au scénario "le plus défavorable" pour la tourbe, principalement parce que ce rythme d'exploitation suppose la sous-utilisation d'une partie du matériel. Le coût unitaire diminue passablement pour une installation de 500 kW, mais il n'a pas été possible de comparer les coûts avec ceux d'une installation diesel de 500 kW qui n'étaient pas disponibles et dont la détermination dépassait la portée de l'étude.

Le coût total de production d'énergie électrique avec une installation diesel de 250 kW s'élève actuellement (1982) à 0,21 $/kW.h. Il était de 0,155 $/kW.h en 1980 et de 0,18 $/kW.h en 1981. Pour l'option "machine à vapeur alimentée à la tourbe et générateur" d'une capacité de 250 kW, on estime le coût à 0,67 $/kW.h. Pour une capacité de 500 kW, le coût de l'installation alimentée à la tourbe se situe à 0,48 $/kW.h pour deux machines de 250 kW chacune, et à 0,43 $/kW.h pour une machine de 500 kW. L'installation alimentée à la tourbe ne peut donc pas produire de l'électricité à un coût plus faible que l'installation diesel actuelle, à l'échelle de 250 kW.

9. Il ne faut cependant pas ignorer les avantages socio-économiques de l'option tourbe y compris des emplois, l'utilisation d'une ressource locale (le remplacement du pétrole) ou les possibilités de récupérer la chaleur résiduelle pour l'utiliser dans une serre, une laverie automatique, etc. Avant de faire une analyse coûts-bénéfices, il faut examiner de plus près la question de la récupération de la chaleur résiduelle.

10. L'objectif principal des résidents de Deschambault Lake est l'électricité à coût peu élevé. L'application de la structure de tarifs pratiquée ailleurs dans la province est la seule façon d'atteindre cet objectif. Il est recommandé de considérer cette approche, quelle que soit l'option énergétique choisie. Il faudrait évaluer ensuite les options uniquement selon le meilleur rendement global sur les plans économique et social pour la collectivité. On s'attend à ce que l'option qui comporte la participation de la collectivité à la solution des besoins locaux en énergie (peut-être avec une aide sous forme de création d'une structure sociétaire et de formation) mérite un examen détaillé.

11. Il faut davantage d'analyses pour choisir la "meilleure" option énergétique pour Deschambault Lake.

Cette étude a été effectuée par Bell, Ahenakew and Associates et Monenco Limited pour le Conseil du hameau de Deschambault Lake (Saskatchewan) à l'aide d'une subvention du Programme de démonstration dans les collectivités éloignées d'Energie, Mines et Ressources Canada.

INTRODUCTION

In the summer of 1983, as the Hamlet Council of Deschambault Lake contemplated local energy related concerns, the problem which was identified as being the most serious was the high cost of electrical energy. A petition had been circulated in the community requesting Sask Power/North Sask. Electric to accelerate plans to connect Deschambault Lake to the provincial power grid. Signatories to the petition anticipated that the removal of the financial disincentive, applied to electrical rates in centres where power is generated with diesel plants, would significantly reduce their electricity bills, and would enable the use of a greater range of electrical equipment.

An "Overview Study" of energy alternatives available to remote Saskatchewan communities was undertaken by Energy, Mines and Resources Canada in the Spring of 1983 and identified four potential energy sources available to the community. They included:

- connection to the Provincial Power Grid;
- development of a small hydro site;
- development of the fuel wood resource; and
- possible use of peat resources.

Council wished to undertake more thorough examination and to this end engaged the firm of Bell, Ahenakew and Associates assisted by Monenco Limited to carry out a pre-feasibility study of the various alternatives.

The study was divided into four work tasks:

Work Task One: An analysis of current and anticipated energy consumption patterns, practices, and problem areas.

Work Task Two: A more detailed assessment of the quantity and quality of the alternate energy sources identified in the overview study.

Work Task Three: Identification of and preliminary cost estimates for the most appropriate technology to utilize the selected option.

Work Task Four: Recommendations concerning the "best" option and a preliminary plan for its implementation.

As originally conceived, the study was to entail a detailed assessment of the various options, the technologies, the costs, and the socio-economic considerations associated with each option. As the current study was being initiated, the anticipated level of funding was not achieved, hence the level of detail of study that could be devoted to the various options had to be reassessed. Since the least was known about the availability and suitability of local peat, most of the revised study effort was directed toward an assessment of its potential.

The Hamlet Council, and the team of consultants retained by Council, were initially hopeful that sufficient information would be readily available to identify the costs associated with each of the options allowing a recommendation of an appropriate course of action. In fact, the choice of a preferred option(s) was not simple for a number of reasons:

- when socio-economic cost/benefit analysis is applied, the process of selecting options became more complex;

- some of the decisions which impact upon the ultimate cost of the options (i.e. the routing of the "northern reinforcement

power line") have not yet been made and are outside the sphere of influence of Council;

- the lack of sufficiently detailed information on some of the options, e.g. mini-hydro: and

- the uncertainty about the level of future increases in power consumption. Many factors may influence future consumption including local economic development initiatives, housing construction program, full sewer and water services, etc. "Economies of scale" effect the price of power for several of the options. The more that is consumed (within limits), the lower the unit price.

ENERGY PROFILE OF DESCHAMBAULT LAKE

2.1 TOTAL ENERGY CONSUMPTION ALL SOURCES - 1981/82

Tables 2-1 and 2-2 were extracted from the Remote Community Overview Study. They are reproduced here since they illustrate that, when compared on a per gigajoule basis, electrical power provides the bulk of the communities energy requirements. It should be noted that for purposes of comparing data from these Tables to others which follow, the user classifications should be grouped under the headings Government, Commercial and Residential.

"Government" at Deschambault Lake includes the school, a nursing station (which shares facilities with the R.C.M.P. and Provincial Resources officers patrolling from Pelican Narrows), a Sask Tel telecommunications tower and a CBC re-broadcasting repeater station, a Band Office, a Community Hall, a hockey arena, the power plant and street lights. "Government" in 1981, when the figures were compiled, was the largest electrical energy consumer. Figure 2-1 is a plan layout of the Hamlet.

2.2 ELECTRICAL ENERGY COSTS

DIESEL-ELECTRIC POWER COSTS

Table 2-3 presents data received from North Sask Electric Ltd., the Sask Power Corporation subsidiary responsible for operation and maintenance of the electrical distribution system in the northern part of the province. The table indicates a steady and substantial year by year increase in residential and commercial electrical consumption. Government consumption peaked in 1981 (during construction and initial operation of the new educational facility), but has since levelled off at around 400,000 kwh/year.

TABLE 2-1

ENERGY PROFILE: SOURCE FUEL CONSUMPTION FOR DESCHAMBAULT LAKE - 1981

Classification	Annual Source Fuel Consumption - Basis 1982 Facilities				
	Electricity[1] (GJ)	Fuel Oil (GJ)	Propane (GJ)	Wood (GJ)	Total (GJ)
Education	7,388	5,031	239	—	12,658
Health	244	—	1,088	—	1,332
Protection	14	39	—	—	53
Communications	920	—	—	—	920
Transport Services	—	—	—	—	—
Other Government	—	—	—	—	—
Community Services	541	1,355	—	—	1,896
Commercial	1,150	542	—	—	1,692
Residential	5,210	1,045	237	7,872	14,364
Total	15,467	8,012	1,564	7,872	32,915

1. Lists the consumption of source fuel (usually fuel oil) required to generate electrical energy, and uses an average performance index of 2.86 kwh/litre of fuel.

Source: Remote Saskatchewan Energy Overview Study
Underwood, McLelland et al.

TABLE 2-2

ENERGY PROFILE: ANNUAL ENERGY CONSUMPTION FOR DESCHAMBAULT LAKE - 1981

Classification	Annual Energy Consumption			
	Electricity (MWH)	Fuel Oil $(x\ 10^3)^L$	Propane $(x\ 10^2)^L$	Wood (Cords)
Education	546	130	88	—
Health	18	—	400	—
Protection	1	1	—	—
Communications	68	—	—	—
Transport Services	—	—	—	—
Other Government	—	—	—	—
Community Services	40	35	—	—
Commercial	85	14	—	—
Residential	385	27	87	480
Total	1,143	207	575	480

Source: Remote Saskatchewan Energy Overview Study
Underwood, McLelland et al.

TABLE 2-3

DIESEL ELECTRIC POWER GENERATION COSTS - DESCHAMBAULT LAKE, SASK.

	1978	1979	1980	1981	1982	1983	1984
TOTAL CUSTOMERS	80	82	89	89	93		
RESIDENTIAL	60	61	63	68	73		
COMMERCIAL	9	8	13	9	11		
GOVERNMENT	11	11	11	10	7		
STREET LIGHTS		2	2	2	2		
TOTAL CONSUMPTION - KwHrs	352,901	400,393	510,001	675,309	902,881		
RESIDENTIAL CONSUMPTION - KwHrs	215,530	218,629	290,733	351,736	401,833		
COMMERCIAL CONSUMPTION - KwHrs	45,781	64,911	72,437	96,177	90,622		
GOVERNMENT CONSUMPTION - KwHrs	87,460	112,741	228,009	318,724	392,192		
STREET LIGHTS - KwHrs	4,130	4,112	18,800	18,669	18,484		
AVERAGE RESIDENTIAL CONSUMPTION - KwHrs/Mo.	299.34	298.7	384.5	4.31	456.9		
FUEL COST PER GALLON	68.4¢	67.6¢	92.7¢	129¢	$1.39		
FUEL USAGE - GALLONS	32,259	46,152	49,241	75,048	99,390		
KwHrs PER GALLON FUEL	10.91	9.68	12.39	12.29	13.58		
FUEL COST PER KwHr	6.45¢	7.79¢	7.44¢	9.93¢	10.25¢		
AVERAGE RETURN PER KwHr RESIDENTIAL	7.95¢	7.76¢	8.14¢	8.13¢	8.284¢		
AVERAGE RETURN PER KwHr COMMERCIAL	14.33¢	14.80¢	14.89¢	15.74¢	17.55¢		
AVERAGE RETURN PER KwHr GOVERNMENT	24.99¢	28.13¢	28.09¢	28.90¢	30.03¢		
AVERAGE RETURN PER KwHr STREET LIGHTS		16.89¢	8.51¢	9.41¢	10.7¢		
TOTAL AVERAGE RETURN PER KwHr SOLD	13.08¢	14.70¢	16.43¢	19.88¢	19.0¢		
TOTAL COST PER KwHr PRODUCED	16.12¢		15.51¢	18.45¢	21.43¢		
COST VARIATION YEAR TO YEAR							
FUEL OIL		-1.18	+36.4	+39.9	+7.75		
RETURN PER KwHr - RESIDENTIAL		-2.45	+4.9	+1.2	+9.93		
RETURN PER KwHr - COMMERCIAL		+1.88	+1.99	+3.71	+11.43		
RETURN PER KwHr - GOVERNMENT		+12.61	-.14	+2.88	+3.9		
RETURN PER KwHr - AVERAGE		+1.62	+13.7	+21.07	-4.42		
COST PER KwHr							

It should be noted when data from this table is compared with 1982 residential consumption data from Table 2-5, Part A, total residential consumption as reported in Table 2-5 is 10% higher. It is common practice to add about 10% to account for unavoidable inefficiencies resulting from "line-loss" in transmission, maintaining the generator at "frequency" at times when no (or very little) power is being metered (sold), fuel losses, etc. The practice has the effect of reducing the reported unit price of electrical power produced. The reported average return per kwh for Residential users was 8.964 cents in 1982. Table 2-5 shows that the actual average return per kwh-Residential, was 9.9 cents in 1982.

RESIDENTIAL ENERGY COSTS

Table 2-4 is compiled from responses to a door to door survey conducted by the study team during Nov/Dec 1983. Heads of households were asked to estimate their annual costs for oil, propane, electricity and wood.

Electrical energy constituted the largest energy expenditure for community residents. 50 of the 73 residential units serviced by electricity, were surveyed. Local estimates of the cost of electricity were later shown to be quite accurate. (Total estimated expenditure on electricity = $22,629.00 x 73/50 = $33,038.00). Our review of actual electrical utility bills showed that total 1982 revenue from residential customers was $35,960.00.

The data was reviewed at a community meeting in February 1984, and it was observed by residents in attendance that these average figures did not adequately illustrate the seriousness of the situation effecting an increasingly large group of residents. Both the North Sask Electric Ltd. information and the survey data indicate an average monthly consumption per residential unit of about

Table 2-4

Survey of Annual Residential Fuel Costs - Deschambault Lake

A.	Oil	
	Users Surveyed	15
	High Annual	$1,500.00
	Low Annual	$300.00
	Total	$11,687.00
	Average	$779.00
	Users with Plumbing Average	$832.00
B.	Propane	
	Users Surveyed	19
	High Annual	$600.00
	Low Annual	$120.00
	Total	$5,644.00
	Average	$297.00
C.	Electricity	
	Users Surveyed	50
	High Annual	$1,260.00
	Low Annual	$90.00
	Total Residential (local estimate)	$22,629.00
	Average	$453.00
D.	Wood	
	Users Surveyed	42
	High Annual	$1,300.00
	Low Annual	$50.00
	Total Value	$16,930.00
	Average	$403.00
	Band Houses Averages	$408.00
	D.N.S./C.M.H.C. Houses Average	$367.50

Local estimates based on responses to door to door survey by Bell, Ahenahew & Associates - Nov/Dec 1983.

450 kwh, at an average cost per customer of $35.00 to $40.00 per month. Several in attendance indicated that they were receiving power bills of from $120.00 to $200.00 per month.

Following the community meeting, the study team, with the co-operation of North Sask Electric, undertook a more detailed analysis of actual residential electrical costs by reviewing power bills sent to customers during the months of January 1983 and January 1984. This data is presented in Table 2-5. The analysis substantiated the concerns of community residents regarding residential electrical costs. When costs are considered on an individual, as opposed to an "average" basis, the following observations were made:

(a) Approximately 70% of the housing stock consists of small units (under 1,000 sq. ft.), equipped with a wood space heater and/or a cook stove. Energy for space heating, domestic hot water and food preparation are obtained from wood. As many as 1/3 of these units are vacant over several months of the winter when families relocate to trap lines or fishing camps. The units consume very little electricity on an annual basis. When their totals are calculated into the average figures, the impression is obtained that the average resident of Deschambault enjoys relatively low electricity costs.

(b) With few exceptions, all housing in the community has been, and in all likelihood will be, provided under one of two "public" housing programs: CMHC/Sask Housing Corporation units constructed under the Section 40 public housing program or Band Housing constructed under a CMHC/DIAND agreement.

Since 1980, all new units constructed have been equipped with water pressure/septic pump out systems. Most of the units have electric hot water tanks. All units are supplied with a combination wood/oil furnace or a "Valley Comfort" type space

heater. These units provide no surface for water heating or food preparation. Occupants are forced to rely on electric ranges for such purposes.

Water pressure systems require that building temperature be maintained above freezing levels, whether the home is occupied or not. All new housing will be built to comply with CMHC standards (the ten new units currently under construction by the band will have water pressure systems).

All houses constructed since 1980 fall into the group consuming 500 or more kwh per month (Jan. 83 and Jan. 84). As new housing stock comes into use, the proportion of residents paying 13¢ per kwh will increase. The high cost of providing services to these units in winter months becomes almost prohibitive for residents without full time employment.

(c) Utility bills of $100.00 to $200.00 per month (in winter) are more serious when seen in the context of community income. The survey indicated that only 16 household heads hold full-time employment (Table 3-1). The rest derive income from seasonal employment, from fishing and/or trapping supplemented by transfer payments. Social assistance contributes substantially to average annual household income.

The DIAND social assistance program provides an allowance of $55 per month per household for utilities costs (winter months only, for employables on assistance). This may be sufficient to cover costs if the source is wood, but it is obviously insufficient to cover the cost of electricity for units falling into the high consumption groups.

Residents have little or no choice in the way their housing is designed, or the type of heating appliances with which it is equipped. Public housing must conform to health and safety

codes which are based upon standards established in other parts of the country. While these standards have the "good intention" of ensuring the health and safety of the occupants, the net effect appears to be to force a higher consumption of electrical energy. Given the current rate structure, as consumption increases, so does unit price. A per kwh price of 14 cents to 17 cents is unaffordable given the average level of household income, and/or the level of assistance provided under the social assistance programs.

Table 2-5 reports total residential electrical consumption for 1982 and 1983 based upon meter readings and customer invoices. Table 2-6 reports electrical service charges as invoiced by North Sask Electric Ltd., based upon meter readings covering two periods. Table 2-6(A) summarizes invoicing information for the period Dec. 12, 1982 to Jan. 12, 1983. Table 2-6(B) reports on the same one month period, one year later (Dec. 12, 1983 to Jan. 12, 1984).

Total residential electrical consumption in the one month period increased by 48% from 1983 to 1984. Much of this increase may be due to more severe weather conditions in 1984 than in 1983 (See Table 2-7). However, this and other data substantiate the local contention that the number of large volume users, and consequently total residential consumption are steadily and substantially increasing.

Table 2-5

Consumer Energy Costs on an Annual Basis Averaged Over All Residential Consumers (1982 - 1983)

1982 — 73 res. Customers
Total Consumption (From Meters) - 365,121 KWH
Revenue - $35,960.00
Revenue/KWH - $0.099

1983 — 80 res. customers
Total Consumption (From Meters) - 374,207 KWH
Revenue - $36,411.00
Revenue/KWH - $0.1028

Table 2-6(A)

Electrical Service Charges - Deschambault Residential
(Dec. 12, 1982 to Jan. 12, 1983 - One Month)

(i) Average

Meters Read	73
Total Residential Consumption	34,093 kwh
Average All Units	467 kwh
Total Service Charges	$3,618.85
Average Charge - All Units	$49.67
Average Charge per kwh	10.6 cents

(ii) Range

	1 Month	Cost	¢/KWH
Low	25 KWH	5.17	20.68¢
High	1759 KWH	265.87	15.11¢

(iii) By Groupings

CONSUMPTION	# UNITS	%TOTAL	KWH	CHARGE	¢/KWH
1.<100 KWH	3	4%	155	$ 18.40	11.87 cents
2. 101-315 KWH	28	38%	5591	322.22	5.76 cents
3. 316-500 KWH	20	27%	8060	618.81	7.67 cents
4. 501-1000 KWH	15	20%	10709	1272.17	11.88 cents
5.>1000	7	10%	9578	1387.25	14.48 cents

Table 2-6(B)

Electrical Service Charges - Residential Meter Readings
Dec. 12, 1983 to Jan. 12, 1984 - One Month

CONSUMPTION	# UNITS	%TOTAL	KWH	$ CHARGE	¢/KWH
1.<100 KWH	2	2.5%	92	$ 11.61	12.62 cents
2. 101-315 KWH	12	15%	2732	178.06	6.52 cents
3. 316-500 KWH	25	32%	10198	895.54	8.78 cents
4. 500-1000 KWH	27	34%	18322	2448.84	13.37 cents
5.>1000	13	16%	19081	3224.36	16.90 cents
TOTALS	79		50425	6758.41	

High - 2106 KWH ($375.35) Low - 2 KWH ($4.97)
Average - 638.3 KWH ($85.55)

Table 2-7

Average Temperatures - La Ronge, Sask.

Dec. 1982	Average Max. Temp. -	12.3°C
	Average Min. Temp. -	21.4°C
Dec. 1983	Average Max. Temp. -	18.2°C
	Average Min. Temp. -	29.1°C

Source: Ministry of Transport, La Ronge, Sask.

The Northern Lights School Division pays the utilities costs incurred by teachers occupying teacherages. There are seven such units included in the Tables. In Jan. 83, five of the seven units, consuming over 1000 kWh/month, were teacherages. In January 84, six of thirteen units in that category were teacherages.

All units with water pressure systems, electric hot water tanks, and forced air furnaces, are included in group #4 or #5 (over 500 kWh).

DIESEL-GENERATED ELECTRICITY SCHEDULE OF RATES

North Sask Electric Ltd. has always assumed that their network of diesel powered generating stations should recover their own operating expenses. Rates have accordingly been structured on the following basis.

a) Residential Northerners should be provided with sufficient power to light their small homes, and operate some small appliances at a rate comparable to those charged grid customers. Because generating capacity was limited, diesel electricity consumers should be discouraged from consuming large quantities. This could be accomplished by charging a "disincentive" rate for consumption over that required to provide basic services (established at 315 kwh/month).

b) Commercial Northern business should buy power at cost.

c) Government Federal and provincial agencies (and later, local government agencies) should be charged a rate which would make up the difference between rates charged to residential consumers, and the actual cost of operations.

Subsequent changes in the rate structure, as approved by the Public Utilities Review Commission, has resulted in overall revenue falling below actual costs of generation, over the past two years.

Current Rate Structure: Effective July 1983

(i) Residential - Basic Monthly Charge $4.65/month
plus $.0398 for the first 315 kwh/month
plus $.19 for each additional kwh/month

(ii) Commercial - Basic Monthly (including first 30 kwh/m) $6.05/month
plus $.079 for next 420 kwh/month
plus $.26 for each additional kwh/month

(iii) Government - Flat rate $.38 per kwh/month

PROVINCIAL GRID RATES

All residences in the province connected to the electrical distribution grid system pay for the service on the basis of the following rates:

Residential: Basic Monthly - Town $3.80
- Rural $4.64
plus .0394 cents/kwh Town
or
.0398 cents/kwh Rural

Commercial and Government: Basic Monthly - Based on Peak Demand Increases from low of $5.80 Town/ $6.80 Rural to $7.65 depending on peak installed demand plus:
.056 cents for 0-15 Kw demand
or
.034 cents for 16-75 Kw demand
or
.0214 cents for 76-100 Kw demand

Costs associated with power generation, transmission, operations and maintenance are recovered through the rate structure applied over the entire grid system. The costs of distributing power to isolated ranches is shared by city apartment dwellers. As northern communities are connected to the provincial grid system, residents immediately begin to share the benefits of rates based on shared cost recovery.

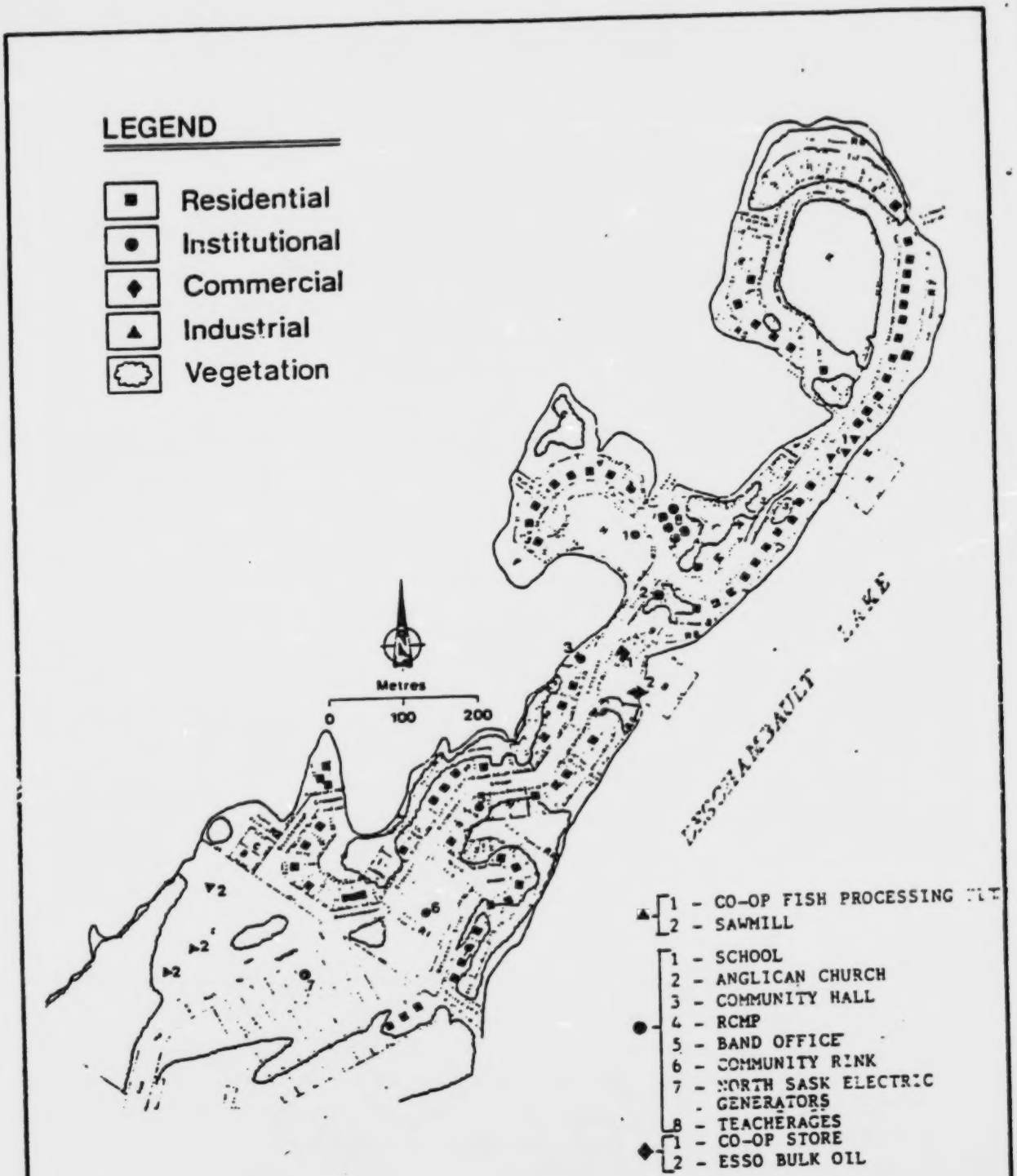


FIGURE 2-1

Deschambault Lake

SOURCE: 1:5000 AIR PHOTO'S 1981 DNS COMMUNITY PLANNING FIELD NOTES & LEGAL PLANS-1979

SOCIO ECONOMIC CONSIDERATIONS

3.1 INTRODUCTION

The community of Deschambault Lake is situated at its present location due to its historical dependency on fishing, and to a lesser extent, trapping. The system of water-ways connecting it to the Sturgeon Weir and Churchill River systems has provided the principal means of transportation and communication.

The settlement at Deschambault Lake began to evolve as a population centre only relatively recently. The church, a trading post/store, a school and fish storage facilities were constructed between 1920 and 1940. The access, all-weather road connecting the community to the provincial highway network was completed in 1975. Most of the housing stock has been constructed since 1960.

Fishing and forestry continue to provide the economic base. There have been periodic bursts of activity in exploration for base and precious metals in the general area, but to date, no mining activities have been initiated.

3.2 RESIDENTIAL SURVEY

The study team, with the assistance of a local representative appointed by the Hamlet Council, conducted a door to door survey of residences. The main purpose of the survey was to determine energy related concerns. However, the survey data also provided some perspective on the general socio-economic circumstances of the community. Survey data is presented in Table 3-1.

Table 3-1 Residential Survey Results

.1 Number of Residences

Total occupied residential units	82
Total Interviews completed	50
Occupants on trapline	18
Teacherages (not interviewed)	8
Units vacant and boarded	3
Units vacant - fire damaged	3

.2 Ownership of Units Surveyed

Band	29
S.H.C./Occupant	18
Private	2

.3 Occupancy

	A. Band	B. S.H.C./Occupant
Total units	29	18
Total occupants	169	102
High	11	8
Low	1	3
Average	5.83	5.6
Occupied private dwellings in Saskatchewan		332,715
Average number of occupants per dwelling		2.8
National Average Occupants		2.9

.4 Household Income

Responses indicating source of most annual income.

Social assistance, training allowance, U.I.C.	24
Pensioners	2
Full-time employment	10
Self employment (trapping, wild rice, etc)	11
Part-time employment	3

.5 Housing Units

Total units built by D.N.S./C.M.H.C.	23
Total on survey	18
Total band houses	52
Total on survey	30
Total School Board	8
Total Private	2

All D.N.S./C.M.H.C. housing has been constructed since 1974. Ten units have been built since 1979 and eight of these have piped water and septic pump out tanks. Sixteen band owned homes have been built since 1979. These have a crawl space. All earlier models are built on cement footings only.

.6 Local assessment of housing quality:

D.N.S./C.M.H.C.

Good 30% Fair 30% Poor 30%

Band

Good 30% Fair 10% Poor 60%

This assessment takes into account:

- original insulation;
- air infiltration around doors and windows;
- space adequacy; and
- general maintenance and conditions.

.7 Space Heat

A. Band Houses Surveyed

- Oil Fired Space Heater	2
- Wood Fired Space Heater Valley Comfort	26
- Wood Fired Tin Heater	1

B. D.N.S./C.M.H.C. Houses Surveyed

- Oil Fired Forced Air Furance only	6
- Combination Wood/Oil Furnace or Oil Furnace and Wood Space Heater	9
- Wood Space Heater Only	3

Electricity or propane is used as a back up source of space heat in six units.

.8 Water Heat

Piped Water and Water Heating Tanks Electric/Propane	8
Electric or Propane Stove	23
Wood Stove	19

.9 Payment for Utilities

Social Services Pay Full Utilities	3
Paid from Cash Income (including Social Assistance)	47

.10 Wood Supply

Cut and Transported by Occupant	34
Cut and Transported by Social Services	3
Pays Someone to Cut and Transport	6
N/A	6

.11 D.N.S./C.M.H.C. Housing Construction By Year

1974 - 4 units	1976 - 3 units
1977 - 3 units	1978 - 3 units
1979 - 4 units	1980 - 3 units
1981 - 3 units	

Seven of twenty surveyed household occupants of D.N.S./C.M.H.C. are Treaty and would be eligible for Band housing.

3.3 RESOURCE OWNERSHIP

The Peter Ballantyne Band has a large outstanding land entitlement. With the co-operation of the previous provincial administration, extensive tracts of unoccupied crown land had been identified and mutually agreed to, to satisfy this claim. These tracts include most of the peat and forest resources which are relevant to this study. The current provincial government has recently indicated an intention to conclude these negotiations and finalize the settlement.

While the ownership of some of the land from which the current project might harvest fuel wood or mine peat might change, the regulations respecting resource use, and the royalty structures will probably not. As indicated elsewhere, however, it should be noted that any firm plans to utilize local resources would have to be negotiated with the local band council.

3.4 ANTICIPATED ENERGY DEMAND

POPULATION GROWTH

From 1974 to 1982, the population increased at an annual rate of 3.3%. The age-sex distribution of the population would indicate that the annual rate of population growth is likely to accelerate over the next 15 years at the age 5 - 19 group (47% of the population) move through the child bearing years (Table 3-2).

TABLE 3.2

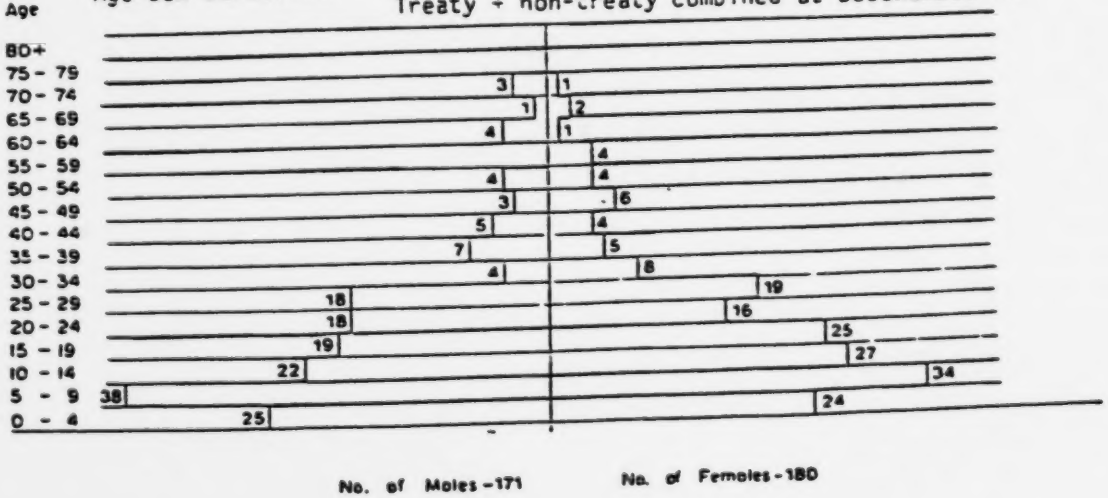
Deschambault Lake Population Statistics

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Population (total) (further information not available)			409						456		517
Growth %	3% medium growth.										

Projected Future Population Growth - @ 3% - 1985/528; 1990/612; 1995/710. Source: DNS - Community Planning Branch.

Ethnic Mix: White ____%
Metis ____% } 20%
(Cree) Indian 80 % Peter Ballantyne Band
Other ____%

Age-Sex Structure - (1978 DNS + Reserve Band List information). Treaty + non-treaty combined at Deschambault.



Using the historical medial growth rate of 3%, D.N.S. Community Planning Branch has projected a 1995 population of 710 persons. A median growth rate of 4% for northern communities with similar age-sex distribution has been assumed by other studies (Midwest Project - Socio-Economic Assessment) and is probably more applicable here.

Not accounting for in or out migration, a 1995 population of 894 persons is expected.

DEVELOPMENT PLANS WITH POTENTIAL IMPACT ON COMMUNITY POPULATION AND ENERGY DEMAND TO 1995

Members of the Hamlet Council were not aware of any development plans which would significantly increase or reduce the local population. They anticipate population growth from natural increase only.

Band Councillors are actively pursuing an economic development program based primarily on forestry. Incorporation of portions of the community and surrounding forested areas into the "reserve", if it is associated with expanded economic opportunity, might entice Band members from Pelican Narrows or Southend to relocate. Housing plans are being designed to accommodate some in-migration. They anticipate 8 - 10 families between now and 1995. (40 to 50 persons). A 1995 population of 940 persons can reasonably be anticipated.

OTHER FACTORS IMPACTING ON ENERGY DEMAND TO 1995

(a) Decreasing number of occupants per unit:

1982 - population 517
- average occupancy 6.3
- no. of residential units - 82

1995 - projected population - 940
- average occupancy drops to 6 persons
- no. of residential units required - 157

Even if average occupancy per unit drops only to 6 persons per unit, the number of residential units required by 1995 will double. Social agencies are hopeful that average occupancy will decline to nearer the national average. The actual average number of occupants per private dwelling in Saskatchewan in 1981 was 2.8 persons. A substantial increase in the number of residential units will have a major impact on residential energy consumption totals.

(b) Upgraded Electrical Service:

If a reliable and unlimited source of electrical power were available to the community and the financial disincentive was removed, there would be an immediate increase in electrical consumption, as electric ranges, clothes dryers, and other electrical appliances were purchased and used.

Experience in northern Manitoba and Saskatchewan has shown that when an isolated community is tied into the provincial grid system, local consumption doubles within the first three years, and increases at an annual rate of 10% to 12% for the next three years before levelling off.

(c) Installation and Hook-Up of Sewer and Water Services:

Fewer than 10% of the residential units in the community are currently equipped with water pressure systems and septic tanks. While there are no immediate plans by either Indian Affairs or the

province to install a full municipal sewer and water system due to the uncertainties associated with the outstanding land entitlement of the Peter Ballantyne Band, and the lack of reserve status for the community, it is a Public Health requirement that all new housing be equipped with water storage tanks, water pressure systems and pump-out facilities. The eleven new units planned for construction in 1984 - 1985 by the Band will all be so equipped, as will all subsequently constructed units. North Sask Electric advise that their experience has shown a 25% - 30% increase in electricity consumption as communities come onto full water and sewer services, and as electric hot water heaters come into use.

The gradual addition of "full service" units to the available housing stock will result in similar increases over the planning horizon of this report.

(d) Industrial Development:

If low cost electrical power were available, the local sawmill would likely convert from diesel to electrical power quite quickly, and additional community services might become viable (e.g. laundromat, fish processing, etc). Over the longer term other small industries which are currently inhibited by high electrical costs, may develop.

(e) The Conservation Option:

Average per unit energy consumption might be reduced over the next 12 years if a conservation program were implemented. For example schools of similar size and construction in other locations have realized energy cost savings of as much as 35% by instituting energy conservation practices, and relatively inexpensive retro-fitting programs.

Band housing is generally more than 5 years old and is insulated to the codes that existed in the early 70's (i.e. R-12 walls, R-20 ceiling). S.H.C./C.M.H.C. housing built since 1978 (about 70% of the current non-band housing) is insulated to R-20 walls and R-40 ceilings.

Retro-fitting, re-insulation and the adoption of energy conservation practices may make housing more comfortable, but is unlikely to have the effect of off-setting any of the factors listed above, which will increase energy consumption.

ELECTRICAL ENERGY DEMAND - 1995

Residential energy consumption has been increasing by an average of 37,200 kWh per year from 1978 to 1982 or 12.6% per year (Table 2-3). Commercial consumption has doubled over the same period. Government consumption has declined slightly over the past two years from a high of 518,724 kWh in 1981 (during construction of the new school) after significant year by year increases previously. With no firm plans for further government capital construction currently under consideration, it is assumed that government consumption will stabilize or increase slightly over the next twelve years.

Table 3-3 shows the anticipated electrical power consumption by the study team by 1995, taking into account the growth, changes and conservation assumptions described earlier. The estimate is 2,077,000 kwh/year without the effects of changing the rate structure.

North Sask Electric Ltd. provided an estimate for the current study of 4,170,740 kwh/year by 1995, based on past experience noting what they expected the effect would be of removing existing restrictions and assuming rates reverted to the standard provincial. Table 3-4 is based on data received from North Sask Electric Ltd.

Electric power consumption can therefore be expected to be between 2 to 4 million kwh/year by 1995, depending on the rate structure applied.

Table 3-3

Anticipated Electrical Consumption by 1995 (Bell et al)

1982 Total Consumption	902,881 kwh
Residential	401,633
Commercial	90,622
Government	392,142

Assumptions

A. Residential consumption will double due to population increase and increased number of residential units:

401,633 x 2 = 803,266 kwh

B. Residential consumption will double again as full water and sewer services units are added to housing stock.

803,266 x 2 = 1,606,532

C. Additional consumption by light industry results in 30% increase over 1982 commercial consumption:

90,622 x 1.3 = 117,808

D. Government consumption declines over period by 10% as conservation options are implemented:

392,142 - 39,214 = 352,928

TOTAL ANTICIPATED CONSUMPTION - 1995 2,077,268 kwh/yr

Table 3-4

Anticipated Electrical Demand by 1995 (North Sask Electric)

	1983	1984	1985	1986
Residential	411 627	574 464	783 360	1 060 800
Commercial	437 332	502 932	578 372	665 127

1987	1988	1989	1990	1991
1 256 640	1 481 760	1 737 216	1 938 816	2 154 816
764 896	787 843	811 478	835 823	860 899

1992	1993	1994	1995
2 389 440	2 640 000	2 911 104	3 201 792
886 725	913 326	940 726	968 948

Assumptions:

A. existing restrictions removed, rates reverted to standard provincial.

B. number of residential dwellings has grown at 8%/year.

C. residential electrical consumption is assumed to increase at 25% per annum for the first three years, at 10% per annum for the next three years, and at 5% per annum until 1995.

D. Commercial load growth was assumed as follows: 15% per annum for the first four years, and 3% per annum thereafter.

The forecast makes no provision for the introduction of any major commercial or industrial loads which might occur. Assuming a similar load factor to that of 1983, the 1995 consumption of 4,170,740 kwh would result in a demand of 1,080 kW.

WOOD AND PEAT RESOURCES - DEVELOPMENT PLANS

4.1 DESCHAMBAULT FUELWOOD ANALYSIS

The following analysis was provided by Newfor Consulting Ltd. of Prince Albert, Sask., under subcontract to the consulting team.

Newfor was asked to confirm the availability of sufficient fuelwood within reasonable access to the community, to provide for conversion to 35,000 to 50,000 gigajoules of energy, and to estimate costs of round and chipped fuelwood landed at Deschambault Lake.

It will be noted that the estimate of costs for landed fuelwood has a very broad range. This is largely due to the fact that site and species specific data is not available. However, round seasonal fuelwood, cut to 8' lengths, landed at La Ronge, retails for about $37.50 per cord.

Inclusion of sawmill waste products in either a wood or a peat-fired generating facility should enhance the profitability of both sawmill and burning facility operations. While no data is available on the anticipated quantity of waste wood from the milling operation, it is assumed that a relatively small quantity is available. The marginal profitability of the sawmill would be enhanced if some of the costs of wood harvesting (access roads, rolling stock, labour, etc.) could be recovered from the sale of waste wood.

WOOD VOLUMES

The accompanying map (Figure 4-1) shows wood volumes by township (for all species, trees over 4" diameter (dbh) in cords) convertible to cubic metres (m^3 at 1 cord to 2.55 m^3 of solid wood). On the same map the area (in acres) contributing to the gross wood volume, classed as productive, and forested land is noted. The area

of burnover (if significant) and of water or swamp is also included. Thus, a picture of the productive land base and present wood volume is gained.

The total of almost 2.5 million cords, for 20 townships, contrasts with 1.5 and 1.7 million cords used by Saskatchewan Power (Overview Study) from lesser areas surveyed. It is not suggested that the gross total volumes are available economically or practically for the project.

To produce 35,000 to 50,000 GJ (Giga Joules, i.e. Joules x 10^9) of heat energy annually it is estimated 3,000 to 5,200 cords of biomass will be needed. This conversion is based in part on the Enfor project P-163 by the Coban Institute of Edmonton. It is also based on conversions from cubic metres of solid (air dried) wood to GJ of heat energy taken from "Canadian Woods: Their Properties and Uses", Table 5.4.

ACCESS

'Reasonable Access' can be taken to mean any present road and trail or water (and ice) combination which lands wood at Deschambault at an economic price. It is calculated that there are presently 21.3 miles of roads and trails giving access to wood within 20 miles of Deschambault. Considering an arbitrary cut allowance of 1 mile on each side of the roads and trails, access to 42.6 square miles of bush is available. Using the average 'stocking' figures for the Deschambault area, this land area would yield at least 125,000 cords of wood of all species and all sizes (4" dbh and over).

Using a similar calculation, water access would yield at least 200,000 cords of wood.

The theoretical AAC (annual allowable cut) using von Mantel's formula as modified in "American Forest Management" by K.P. Davis (P. 130) suggests 2,500 cords of the road access wood can be cut annually in perpetuity and 4,000 cords of the water access wood can be cut annually in perpetuity.

Provided access to the abundant, mature stands across the lake can be gained one year out of three and that sufficient material harvested and delivered to Deschambault, the AAC figures suggest that there is more than enough wood within a reasonable radius of the village to supply a central energy plant.

FOREST REGULATIONS

Under the Forest Act and Regulations, a harvesting operation of wood (and peat) such as will be necessary if one is chosen for energy provision, would require relatively detailed pre-planning, including:

- road and trail location,
- volume cruising and marketing,
- provision to protect timber species, etc., and a
- provision to provide for regeneration.

Initially, the operation could file for an annual harvesting permit, but with time a five-year term cutting permit or 20-year agreement would be preferable. This is of interest since a reduction in stumpage dues may be applicable. Present fuelwood stumpage rates are:

- white birch	$1.00/cord
- aspen	40¢/cord
- jack pine	50¢/cord
- all other species	75¢/cord

Cutting is allowed only in designated (usually salvage) stands. Fire killed stands often have a 50% (sometimes higher) reduction in stumpage rates.

The Deschambault area shows a preponderance of S black spruce and S jack pine stands followed by H aspen, S white spruce, and mixed wood (SH and HS) stands.

For longer term projects, such as proposed, provision would have to be made to ensure regeneration of stands. Complete biomass harvesting such as recommended by Coban, would make planting preparation easier. Additional costs would be negligible for aspen and HS stands. If (probably over-mature) white spruce cutting were permitted, its regeneration and black spruce could be expected to be the most expensive, totalling about $300/hectare ($120/acre).

Review of the assumptions underlying the above costs is advised, since a case can be made that payment of stumpage, especially on an annual permit basis, absolves an operator from assuming further costs but transfers same to the landowner. The AAC calculations used above depend on natural and/or artificial regeneration of cut sites within a reasonable time (say 5-10 years).

Note: species denoted S or H assume at least 75% of that species e.g. S black spruce means at least 75% black spruce, H aspen means at least 75% aspen.
SH mixed wood means at least 50% softwood and at least 25% hardwood, and HS mixed wood means at least 50% hardwood and at least 25% softwood.

OTHER RESOURCE USES

The most compatible use of fuelwood at Deschambault would be from a resumed sawmill operation, since over 50% of trees delivered end up as waste (as sawdust, 'wane' or 'pane'). In addition, tops, branchwood and foliage could be retrievable at minimal cost.

It is not envisaged that harvesting fuelwood would pose any serious problems. It is expected pre-planning would isolate any possible problems, and solutions could be developed to avoid harmful effects to wildlife, fish or the environment generally.

RESOURCE OWNERSHIP

The Peter Ballantyne Indian Band have an outstanding land claim in the Deschambault area. While this may make approval of land for fuelwood harvest simpler, it would not alter the process radically, and the overall AAC figures would be expected to apply. It could mean that stumpage payments and possible assumption of regeneration responsibilities, would rest with the Band rather than the Province.

4.2 FUELWOOD HARVESTING COSTS

Large scale wood harvesting for energy provision was costed at $30 per oven dry tonne in 1977 by InterGroup Consulting Economists. The Coban Institute concluded with costs of $21.08 and $22.81 per oven dry tonne, for aspen, using machine harvesting in 1981. Present logging costs for aspen for pulping trials and for building logs are markedly higher than this in the Prince Albert area; ranging from $42 to $57 per cord (minimum of $84/odt). However, this

includes much longer haul distances as well as sizeable contributions for fringe benefits, administration, sorting and road building, all of which should be considerably reduced at Deschambault.

However, machine harvesting may not be practicable at Deschambault; the Coban study shows a large increase in costs if conventional chainsaw and skidder methods are used. Omitting chipping, these costs are comparable to the local figures.

The range of costs which could be anticipated is therefore broad, from $21.88/odt ($10.94/cord) for a fully mechanized operation (Dika side cutter, forwarding and chipping at landing) to over $100/odt ($50/cord) using saw and skidder and including allowances for selective cutting, road construction, etc.

From Table 4-1 it can be shown that to produce 35,000 to 50,000 GJ of heat would require 1,820 to 2,600 odt of wood chips, or about 3,640 to 5,200 cords of wood, costs from $40,000 to $ 57,000 for fully mechanized operation (to chip stage only), to $128,000 to $182,000 for chain saw - skidder style operation (to chip stage only). With such a range, and within the confines of this preliminary study, it was only possible to estimate total manpower requirements at 730 to 1,050 mandays up to and including the chipping stage.

Table 4-1

Sample Harvesting Costs by Work Items (Coban Study)

Item	Cost Range $/odt* Low	High	Example	notes
Felling	0.60	4.30	4.00	saw - machine
Skidding	10.00	35.00	30.00	with saw only
Forwarding	5.35	6.65		with machine only
Loading	5.35	6.65	6.10	saw
Trucking	6.73	17.15	15.00	
Unloading	1.10	1.40	1.20	saw
Chipping	8.40	12.90	12.90	
Stumpage	.80	2.00	.80	tA - wB
			70.00	Range: 21.88-72.70 (incl. stumpage)

Conversions Used:

Assumed that 2 cords produce 1 odt (oven dry tonne) and 1 odt produces 19.2 GJ (giga joules). The 2 cord=1 odt conversion avoids converting from green tonnes to odt, which naturally vary with moisture content (e.g. 1 green tonne @ 35% moisture content yields 0.652 odt).

4.3 PEAT RESOURCES

FIELD WORK

A modest field program to determine the availability and suitability of fuel peat in the Deschambault Lake area was carried out during late October, 1983.

A total of eight deposits were checked (See Figure 4-2). The location of each deposit is shown on the attached topographical maps. Bog No. 1 is closest to Deschambault Lake Community and is situated about 8 km south of the village while No. 8 is furthest away located about 32 km to the south. A total of forty-five sites were drilled on the deposits and at one location (Bog No. 6) a sample was extracted for further laboratory analysis.

BOG NO. 1

This deposit is located about 8 km south of the Deschambault Lake Community, immediately to the west of the Deschambault Lake Road. It covers about 20 hectares. The peat layer is shallow, only 120 cm at its maximum and is composed of horticultural moss peat with an average degree of humification of H 2.9. The surface vegetation classification cover is BEI; not suitable for peat excavation.

Co-ordinates: - Easting: 6054
- Northing: 60797
- Zone: 13

BOG NO. 2

This bog is located about 9 km south of the Deschambault Lake Community and immediately to the east of the Deschambault Lake Road at the 20 km post. The total peatland area is about 20 hectares.

Surface cover classification is BEI. The peat layer is shallow, only about 90 cm at its maximum and is composed of horticultural sphagnum peat. It is not commercially useable.

Co-ordinates:
- Easting: 6090
- Northing: 60789
- Zone: 13

BOG NO. 3

This bog is located about 14 km south of the Deschambault Lake Community on the east side of the Deschambault Lake Road. It covers a total of about 25 ha. The central part of the bog is open with Sphagnum fuscum as the main surface element. The edges are treed with a BEI cover. Only one site in the middle of the bog was drilled. It contained 320 cm of quite pure sphagnum peat with an average degree of humification H 3.2. The surface layer is 280 cm thick, with an average degree of humification of H 2.8. This deposit could be a small-scale source of horticultural peat, however, it is not suitable for fuel peat extraction.

Co-ordinates:
- Easting: 6070
- Northing: 60748
- Zone: 13

BOG NO. 4

This bog is located about 16 km south of Deschambault Lake Community. The southeastern lobe of the bog borders on the Deschambault Lake Road while the western portion extends about 2 km west of the road. The deposit is about 130 ha in size.

A preliminary study of the bog was made. A line along its main axis was drilled; total length of the line was 960 m. The approximate location is shown in Figure 4-2.

The surface cover is mainly composed of BEI type cover. There is a variation between fen and bog vegetation on the bog which is also reflected in the variation in pH (5.5 - 4.8 respectively). A pattern of strings was visible indicating a gradient facilitating drainage.

The average thickness of the peat layer along the survey lines was 2.4 m for the area over 2 m in thickness and about 2.2 m for the length of the entire line. The average thickness of the surficial layer is 90 cm. This may detract somewhat from the value of this deposit as a source of fuel peat. It is in part caused by high sphagnum mounds characteristic to parts of this deposit. The peat is mainly sedge-dominant. The average degree of humification of the entire surveyed area is H 4.1. The total peat volume in this deposit is estimated to be about 2.8 million m^3.

The drainability of the deposit appears to be good. However, a more thorough survey is needed to prepare a final assessment. The deposit has some potential for fuel peat extraction but a thorough survey is needed if it is to be considered for use.

Co-ordinates:
- Easting: 6060
- Northing: 60725
- Zone: 13

BOG NO. 5

This bog is located about 18 km south of Deschambault Lake Community about 500 m west of the road near the 10 km post. It extends about 1 km north of a small lake and covers about 90 ha.

The surface cover is BEI with signs of fen type vegetation with a pH of about 5.5. The bog has a string pattern with a gradient towards the lake which is to the south. Due to the high water level of the lake the drainability of this deposit is questionable and

probably impractical. A further survey is needed for drainability assessment. Due to the apparently difficult drainage, only a 500 m survey line was drilled (See the attached map, Figure 4-2).

The total average thickness of the peat layer along the survey line was 3.3 m. The average thickness of the unhumified layer along the survey line was 1.7 m. Along the northern part of the line the layer is, on average, 2.3 m thick. The total quantity of peat is approximately 2.5 million m^3.

The total average degree of humification is H3.6. In most parts of the bog the predominant peat type is sphagnum peat with sedge as the subdominant constituent. The low degree of humification precludes the deposit as a source of fuel peat and the difficult drainage conditions may render it impractical for commercial use.

Co-ordinates: Easting: 6064
Northing: 60702
Zone: 13

BOG NO. 6

This deposit is located about 25-30 km south of Deschambault Lake Community just north of Highway 106. The bog is about 500 to 600 m east of the Deschambault Lake Road and stretches about 7 km west almost to the shores of Deschambault Lake. The total area is about 2000 ha. For the purpose of a preliminary check, a 1580 m survey line was drilled on the southern part of the bog located as shown on the attached Figure 4-3.

Approximate Co-ordinates:
- Easting: 6060
- Northing: 60630
- Zone: 13

The direction of the drainage is marked on the attached map with blue arrows. The deposit is composed of some bog-type areas as well as large areas of fen - string fen type. The presence of the fen complexes indicate a that drainage gradient exists. The gradient should be quite pronounced to about the middle of the deposit. From that point on towards Deschambault Lake, the surface gets flat and is low-lying which could create drainage problems. Also in the middle part of the deposit there are areas of scattered permafrost judging from the airphoto pattern. At the time of the survey, there was about 5 to 15 cm of water ponded in the rimpis. There was slow flow in the middle of the bog. For the final drainability assessment a levelling transect along the main axis is required.

The total average thickness of the peat layer is 2.2 m for the entire deposit while, for the area containing more than 1 m of peat, the total average thickness is 2.6 m. The average thickness of the surficial unhumified layer is 70 cm. The total average degree of humification is H 3.9.

The predominant peat type is sedge peat with sphagnum and or shrub peats as subdominant types. The underlying soil varies from sand to clay.

A peat sample from Bog No. 6 was taken from location B 900W and sent to the Ontario Research Foundation Laboratory for analysis. Results were as follows:

Parameter	Value (Dry Basis)
Carbon	48.46
Hydrogen	6.13
Nitrogen	2.84
Sulphur	0.42
Chlorine	<100 ppm
Ash	6.02
Oxygen (by difference)	36.13
Volatile Matter	56.55
Fixed Carbon	37.43
Calorific Value (C.V.)	8739 Btu/lb
Ash Fusion Temperature	1380°C + 100°C
Moisture Content After Air Drying	11.53%
C.V. of Air-Dried Material	7732 Btu/lb

Total Carbon content is somewhat lower than one might expect (e.g. 50-60%) but variations are sometimes due to laboratory procedures. Otherwise the sample appears to have values quite common for fuel peat.

This bog has good accessibility and further survey work is warranted to determine actual fuel peat development potential.

BOG NO. 7

This deposit is located about 26 km south of Deschambault Lake Community to the east of the Deschambault Lake Road. The total area of the deposit is about 575 hectares. A 1000 m survey line was drilled at the location shown on the attached Figure 4-4.

Co-ordinates: - Easting: 6090
- Northing: 60650
- Zone: 13

It is possible to drain at least the southern part of this bog. However, scattered permafrost was found along the survey line. Because of this, it is considered impractical to consider this bog for use, at this time.

Total average peat thickness was about 2.6 m along the survey line. The average thickness of the surficial layer was about 1.9 m with most of the peat being Sphagnum peat with a degree of humification of H 4 or less. The deposit was mostly covered by BEI - type vegetation as well as small areas of EI cover.

This bog is not recommended for exploitation at this stage. A further survey could be done to check the extent of the permafrost.

BOG NO. 8

This bog is located about 32 km south of Deschambault Lake Community. It is too shallow and small to be considered for utilization.

SUMMARY OF PRELIMINARY PEAT RESOURCE INVESTIGATION

Of the eight deposits checked, Bog No. 6 could be considered for potential use but further survey work is required to confirm the areal extent, peat depth, quantities, and drainability as well as peat quality. Generally, the peat resource potential appears very good in the general vicinity of Deschambault Lake (i.e. 50-75 km radius).

There are a number of large peat deposits south of the main highway south of Deschambault Lake with potential for utilization. However, due to budget constraints they could not be included in the present study.

4.4 PEAT MINING - DEVELOPMENT PLANS

MINING CRITERIA

The estimate of mineable peat resources was based on the following criteria:

- the minimum depth of the peat mining layer at start-up to be at least 1.5 m;
- the ash content of harvested peat not to be greater than 15% on average;
- the surface layer of peat of about 0.3 - 0.5 m is removed in bog preparation and the peat is not used commercially;
- a layer of at least 0.3 - 0.5 m of peat to be left at the bottom of the bog after the area is completely exploited;

- the minimum average degree of humification of the mining layer of peat to be VPH-4.

RESOURCE POTENTIAL OF THE PEATLAND

The preliminary survey of the suitability and availability of peat resources in the Deschambault Lake area showed that of eight peatlands studied, one deposit (Bog No. 6) has potential as a resource for fuel peat production.

The total area of Bog No. 6 is about 2,000 ha; the mineable area with a depth of peat of more than 1.5 m is approximately 1,000 ha. The potential recoverable resource totals about 1,700,000 tonnes of air-dried peat @ 35% m.c. (the practical yield of dried peat, 35% m.c., from a cubic meter of raw peat is about 0.11 tonnes).

MINING REQUIREMENTS

According to the design of the small peat-fired boiler/steam engine unit considered for the Deschambault Lake Community, the annual peat requirement is about 5000 tonnes of air-dried peat at 35% moisture content. Approximately 100 ha (gross) of peat deposit area with a depth of more than 1.5 m and VPH4+ degree of decomposition is sufficient for this scale of production for 20 years.

The total average thickness of the peat layer is approximately 2.2 m for the entire deposit, while for the area containing more than 1 m of peat, the total average thickness is 2.6 m. The average thickness of the surficial unhumified layer is about 70 cm (average degree of humification about H2.5) and the

average thickness of the humified layer is about 1.9 m (average degree of humification is H-4.5+). The total average degree of humification is H3.9.

The thickness of the mining layer cut per season is expected to be about 12 cm and the peat layer is expected to compact about 0.5 m after drainage. The total recoverable peat thickness is expected to be sufficient for harvesting at full capacity (203 tonnes/ha/year) for:

$$\frac{1.9 \text{ m} - 0.5 \text{ m}}{0.12 \text{ m}} = 11 \text{ years, or}$$

approximately half of the overall mine life.

CONCEPTUAL MINE PLANNING (SMALL-SCALE OPERATION)

.1 Climatic Analysis

Table 4-2 shows the main climatological information gathered on the Deschambault Lake area in the course of the current investigation. While climatic[1] conditions may indicate that a specific area may be suitable for a peat mining operation, day to day weather[2] may hamper or even occasionally preclude operations. Examination of the climatological information shows:

1 Climate: The average course or condition of weather at a particular place over a period of many years as exhibited, e.g. in absolute means of weather elements.

2 Weather: State of atmosphere at a definite time and place with respect to weather elements (e.g. temperature).

TABLE 4-2

COMPARISON OF CLIMATIC DATA

	Flin Flon Manitoba	Island Falls Saskatchewan	Nipawin Saskatchewan	La Ronge Saskatchewan	Chatham New Brunswick
Length of Average Frost Free Period (Days)	119	106	108	104	122
Average Date of Last Frost (Spring)	May 22	May 30	May 27	May 28	May 22
Average Date of First Frost (Fall)	Sept 19	Sept 14	Sept 13	Sept 10	Sept 21
Average Hours of Bright Sunshine, May-September	Not Available	Not Available	1348	Not Available	1050
Mean Daily Temperatures May-September (°C)	13.7	12.3	14.5	12.6	15.1
Mean Daily Maximum Temperatures, May-September (°C)	18.8	17.9	21.2	18.4	21.1
Mean Total Precipitation May-September (mm)	305	328	267	337	410
Potential Annual Evapotranspiration (mm)	564	522	556	Not Available	544
Average Annual Water Deficiency (mm)	148	92	168	Not Available	44

Notes: 1) The Chatham, N.B. information is based on the period 1941-1970.

2) The potential annual evapotranspiration and the average annual water deficiency figures for Flin Flon, Island Falls and Nipawin are based on the period 1941-1970.

3) All other information presented in the table is based on the period 1951-1980.

.11 Frost Free Period Deschambault Lake is about 110 days or 10 days shorter than, e.g. Chatham, N.B. With the permafrost conditions found in this area, it indicates some problems with lingering frost in the ground. The drainage should be so designed that the ground stays as dry as possible before the snowfall to avoid frost penetration and creation of permanent frost lenses; otherwise the period appears long enough.

.12 Sunshine Usually high in this area as compared with Chatham N.B.; Nipawin 1348 hrs. vs. Chatham, N.B. 1050 hrs/yr which indicates good drying weather.

.13 Average Temperatures They are about 1.5 - 2° less than in Chatham, N.B. for May to September. This may be caused by cooler nights than encountered in the maritime climatic conditions in Chatham, N.B. The warmer days should balance this.

.14 Precipitation It is about 100 mm less than in Chatham, N.B. Also due to the continentality, the rains may come in bursts as a function of thunderstorms thus leaving extensive drying periods in contrast to the coastal areas where the rains often are distributed over a longer time period. (cf. sunshine hours).

.15 Potential Evapotranspiration It is about 20 mm higher than in the east. This, combined with a lower rainfall, gives a water deficiency which appears to be up to three times higher than in the east. This is a good indication of favourable drying conditions as compared with the established peat mining area such as Chatham, N.B.

One of the main problems may be the frost in the ground. Otherwise, climatically, Deschambault Lake appears to be better suited for peat production than, e.g. Chatham in N.S. This comment is based on the preliminary assessment of climatological information, but it will be necessary to examine the meteorological data in more detail if interest in the project continues.

.2 Key Mine Planning Assumptions

The following assumptions have been used as a basis for conceptual mine planning:

a) sufficient mineable resources exist at Bog No. 6 for an annual sod peat production of about 5500 tonnes, air-dried peat at 40% m.c. (equivalent to about 5100 tonnes at 35% m.c.) slightly larger than the generating plant requirement of 5000 tonnes 40% m.c.

b) Sod peat mining operations are assumed to commence on June 5th, based on the following:

- the average date of the last frost (in Spring) in the Deschambault Lake area is May 28th, and

- since the top layer of the peat deposit requires thawing to a depth of 20-25 cm, therefore, mining operations can only begin on, approximately, June 5th.

c) Statistical data shows that for the period June - July there have been, on average, 5 - 6 days of precipitation more than 10 mm; assume 6 days.

- total length available at harvesting season:

Start: June 5th)
) Total: 88 days (Tseason)
Finish: August 31st)

d) The drying and harvesting cycle is estimated to be approximately 34 days (Tcycle = 34) for sod peat with a diameter of 80-100 mm.

e) Number of cycles per season determined by formula:

$$Ncycle = \frac{Tseason - Tcycle}{Tcycle} = \frac{88-34}{34} = 1.6$$

f) The harvesting yield per cycle (g) was calculated to be about 127 tonnes air-dried sod peat, 35% m.c., from 1 ha.

g) The harvesting yield from 1 ha of mining area per season, (G) =

$$G = g \times N = 127 \times 1.6 = 203 \text{ tonnes/ha per season dried sod peat 35\% m.c.}$$

h) Net mining area requirement, ha (An):

$$An = \frac{\text{Yearly Tonnage}}{G} = \frac{5100}{203} = 25 \text{ ha}$$

i) Gross mineable area requirement, ha (Ag):

$$Ag = \frac{An}{f \times f'} = \frac{25}{0.47 \times 0.93} = 57 \text{ ha}$$

j) Net capacity of sod peat machine per hour - 6.6 tonnes of air-dried sod peat at 35% m.c., for the period June 5th - July 28th.

k) Net capacity of sod turning equipment per hour - 0.126 ha, for the period June 13th - August 11th.

l) Net capacity of sod ridger per hour - 0.44 ha, for the period June 26th - August 16th.

m) Net capacity of sod loader per hour - 0.165 ha, for the period July 5th - August 31st.

n) Net capacity of screw leveller per hour - 0.14 ha.

o) Net capacity of levelling blade per hour - 0.34 ha.

p) In addition to the fuel peat production, it will be possible to have 2100 tonnes/year of horticultural milled peat at 50% m.c. over a 10 year period, equivalent to about 2400 bales per year from 1 ha of mining area.

.3 Selection of the Mining Area

After studying the preliminary resource information for Bog #6, three zones (A, B and C) have been established (See Figure 4-5). It is expected each zone may prove to have different characteristics regarding drainage, surface gradient, water resources, plants, trees, etc. Zone A has been chosen for this study for placement of the mining and drainage plans and for method and equipment selection and cost estimation purposes. Zone A appears to offer the advantages of being a rather featureless bog (i.e., little tree cover, flat, etc.) and could be expected to have lower surface preparation costs than other locations. The proposed mining area is nearby to the main water course, minimizing length of drainage channels. The distance from the bog to the Deschambault Lake road is about 2 km, giving relatively easy access for peat transport.

It is assumed drainage of the proposed mining area can be readily effected, however, further survey work including a levelling traverse and determination of spring flood conditions will be required before confirming the proposed mine site location. If drainage/ flooding is later determined to be a potential problem at this location, there exists similar peatland area at higher elevation to the southeast (Zone B) which is available and should present no drainage problems.

Zone D (between A and B) appears, from airphotos, to be mainly permafrost; additional survey work will be required to delineate the permaforst zones since they can create problems in the design of the drainage system.

4.5 MINING COST ESTIMATE

The attached tables include details on the estimated capital and operating costs for a 5100 tonne/year (35% m.c.) sod peat production facility. Tables 4-3 and 4-4 present estimated labour and rental costs of $200,000 and $122,100 respectively for the pre-production period. Tables 4-5 and 4-6 summarize the estimated capital and operating costs, $308,100 and $124,400 respectively, for the production period at rated capacity. Table 4-7 outlines the capital costs of ancillary facilities. These costs total $257,300. All costs are shown distributed over the years it is expected they will occur.

Figure 4-6 shows a project development schedule for the project. It indicates when the various work activities can be expected to occur if a mining operation were implemented and the duration of the pre-production period.

4.6 TRANSPORTATION COSTS

A preliminary analysis of transportation costs (based on Transport Canada's "Operating Costs of Trucks in Canada, 1982") was carried out under the following assumptions:

- a 30 km one-way haul distance;

- travel is on gravel road;

- a 5 day work week,

- a 16 week haul season, and

- a tandem truck haulage vehicle (40 m^3).

It was estimated that peat haulage would cost about $0.26/tonne km for the haul distance envisaged for this project.

TABLE 4-3

Initial Pre-Production Equipment List and Rental Cost Estimate
(5100 Tonne/Year Sod Peat Operation - Zone A)

Item	Requirement	No. of Rental Units	Unit [1] Rental Costs ($)	$
Hydraulic excavator (V-Shape bucket)	9.8 km	1	$1,300/km	
Kopo-Ditcher	1 mo.	1	$2,400/mo.	
Half-Track 70 H.P. tractor	1 mo.	1	$4,000/mo.	
2 WD - 42 H.P. tractors	3 mo.	7	$3,000/mo.	
Bog Wagon	3 mo.	4	$1,250/mo.	
Fuel, maintenance, shipping costs, etc.		Allowance		25,000
Total Estimated Pre-Production Rental Costs				122,100
			Project Year -2	24,100
			Year -1	98,000
These expenditures are required to be duplicated in Project Year 9				24,100
			Year 10	98,000
				122,100

Notes:
1) One month minimum rental charge has been assumed.

TABLE 4-4

Pre-Production Labour Costs
(5100 Tonne/Year Sod Peat Operation - Zone A)

Item	Manmonths	Monthly Costs ($)*	$
Labour			
Ditching	3	2,800	
Tree felling	2	2,400	
Ice piling	4	1,600	
Tree removal	1	2,800	
Profiling	1	2,800	
Unhumified peat loading	18	2,800	
Unhumified peat transportation	24	2,400	
Field levelling	1	2,800	
Sub-Total:			136,000
Supervision:			
Preproduction - Production Foreman	12		32,000
Maintenance Mechanic	12		32,000
			64,000
Total Estimated Pre-Production Labour Costs:			200,000
		Project Year -2	16,400
		Year -1	183,600
These expenditures are required to be duplicated in		Project Year 9	16,400
		Project Year 10	183,000

*Based on an average labour rate and includes fringe benefits.

TABLE 4-5

Production Equipment List and Capital Costs
(5100 Tonne/Year Sod Peat Operation - Zone A)

Equipment	No. of Units	Unit Price ($)	($)
Sod Peat Machine	1	22,900	
Sod Turner Machine 1 m	1	12,100	
Sod Ridger 4.5 m	1	10,100	
Sod Loader Screen	1	27,000	
Screw Leveller (5.7 m)	1	30,000	
Levelling Blade	1	11,000	
Tractor 100 H.P.	1	55,000	
Tractor 75 H.P.	1	40,000	
Tractor 55 H.P.	1	25,000	
Bog Wagon, 15 m^3	2	12,500	
Miscellaneous Equipment (Levelling Blade, Front End Loader Attachment, Crawler Gear Assembly, Treepuller, Tools, etc.)		Allowance	50,000
Total Estimated Production Capital Costs Equipment [1]			308,100

Note:
1 Costs exclude possible duties, taxes, shipping charges and engineering costs for equipment specification, selection and procurement.

TABLE 4-6

Annual Operating Cost Estimate
(5100 Tonne/Year Sod Peat Operation - Zone A)

Item	Manshifts/Season	$/Manshift*	($)
Production Labor			
Sod peat extruding	112	120	
Drying	120	120	
Ridger	15	120	
Loading	40	120	
Transport to Bogside	40	120	
Sub-Total			39,240
Surface Preparation Labour			
Profiling	60	120	
Levelling	30	120	
Sub-Total			10,800
Powered Equipment	Hours	Hourly M & S**	
Extruding	725	8.00	
Drying	640	7.00	
Ridging	120	7.00	
Loading	260	8.00	
Transport	260	7.00	
Profiling	410	8.00	
Levelling	160	7.00	
Sub-Total			19,420

TABLE 4-6 (Continued)

Annual Operating Cost Estimate
(5100 Tonne/Year Sod Peat Operation - Zone A)

Item	Manshifts/Season	$/Manshift*	($)
Non-Powered Equipment	Hours	Hourly M&S	$
Extruding	768	3.50	
Drying	640	3.50	
Ridging	96	3.00	
Loading	248	3.50	
Transport	248	3.00	
Profiling	408	3.00	
Levelling	160	3.00	
Misc. Equipment	180	2.50	
Sub-Total			8,980
Miscellaneous (camp. maintenance, etc.)			12,000
Supervision			
Clerk/Manager	3	$3,000/mo.	
Production Foreman	5	$2,500/mo.	
Maintenance Mechanic	5	$2,500/mo.	
Sub-Total			34,000
Total Estimated Annual Production Operating Costs:			124,400

* based on an average hourly labour rate of $15.00/hr which includes fringe benefits;

** maintenance and supply costs.

TABLE 4-7

Estimated Capital Costs of Service Facilities
(5100 Tonne/Year Sod Peat Operation - Zone A)

Item	Description	Estimated Cost ($)
Access Road	Appx. 1.8 km X $40,000/km	72,000
Bog Road	Appx. 2.0 km X $30,000/km	60,000
Field Bridges	45 X $185	8,330
Perimeter Bridges	5 X $340	1,700
Stockpiling Access	2 X $2,235	4,470
Fire Wells	3 X $450	1,800
Service Building	15 m X 20 m	38,000
Services	Electrical hook-up, water supply, fuel tank, telephone, etc.	10,000
Miscellaneous	Service Equipment and tools	1,500
Total Estimated Costs of Service Facilities		197,000
	Project Year (-2)	26,000
	(-1)	170,000
Estimated Cost of Additional Services Facilities Required in Year 9.		61,300

INDEX

VOLUME ALL SPECIES
IN CORDS
(1 CORD = 2.55M^3 SOLID WOOD)

TOTALS

1,897,200 SOFTWOOD
575,700 HARDWOOD
2,472,900 CORDS

FOREST AREA (IN ACRES)
PLUS BURN OVER
PLUS WATER
PLUS SWAMP

190,640 FOREST AREA
+ 20,400 B.U.
+148,000 WATER
+108,000 SWAMP
467,040 TOTAL ACRES

FIGURE 4-1

LAKE DESCHAMBAULT PEAT STUDY

DESCHAMBAULT LAKE FUELWOOD ANALYSIS

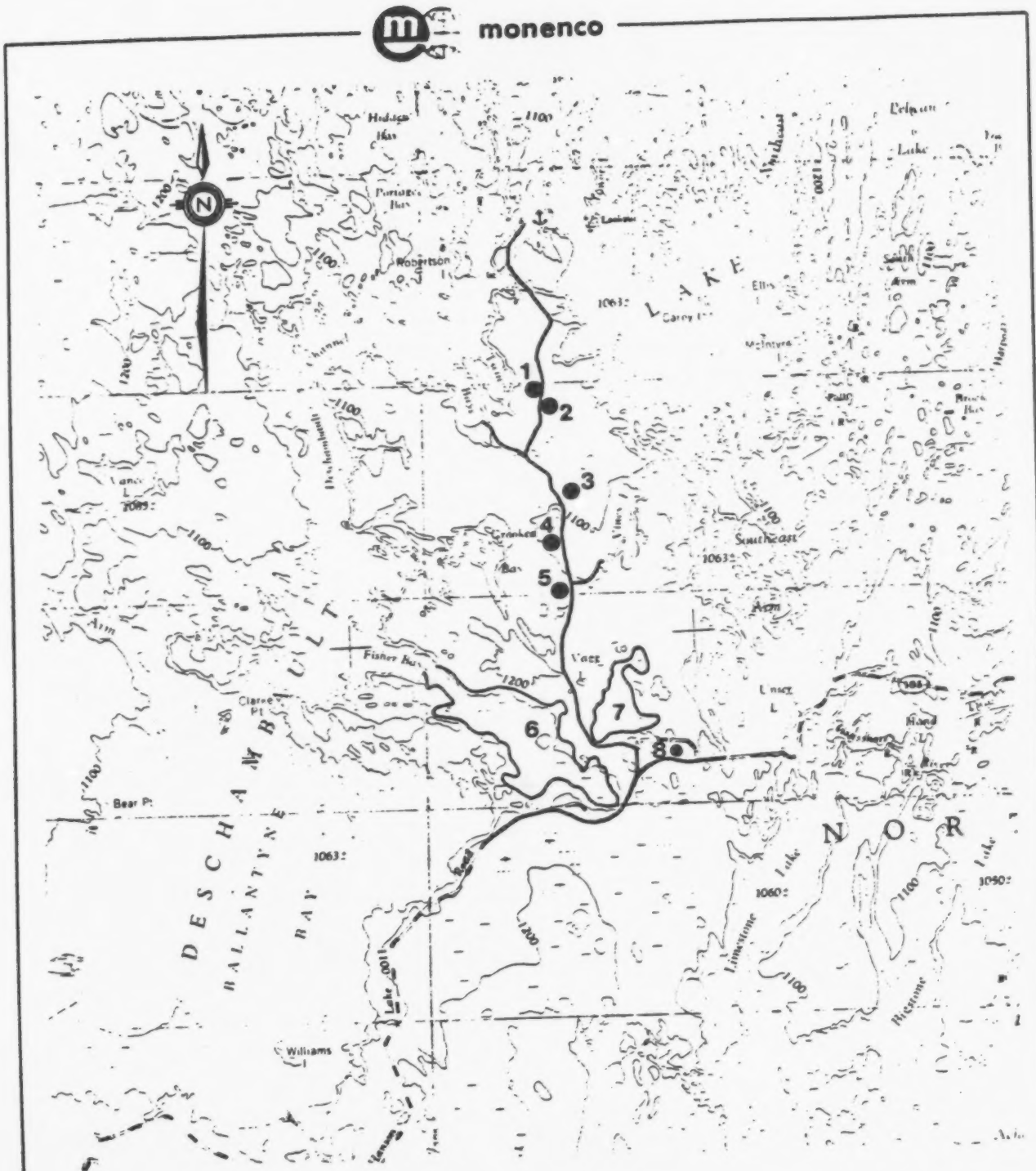


FIGURE 4-2

LAKE DESCHAMBAULT PEAT STUDY

PEAT DEPOSIT LOCATION MAP

• SURVEY POINTS

PEAT SAMPLE LOCATION

FIGURE 4-3

LAKE DESCHAMBAULT PEAT STUDY

BOG No. 6 - SURVEY LINE LOCATION

monenco

• SURVEY POINTS

FIGURE 4-4

LAKE DESCHAMBAULT PEAT STUDY

BOG No.7-SURVEY LINE LOCATION

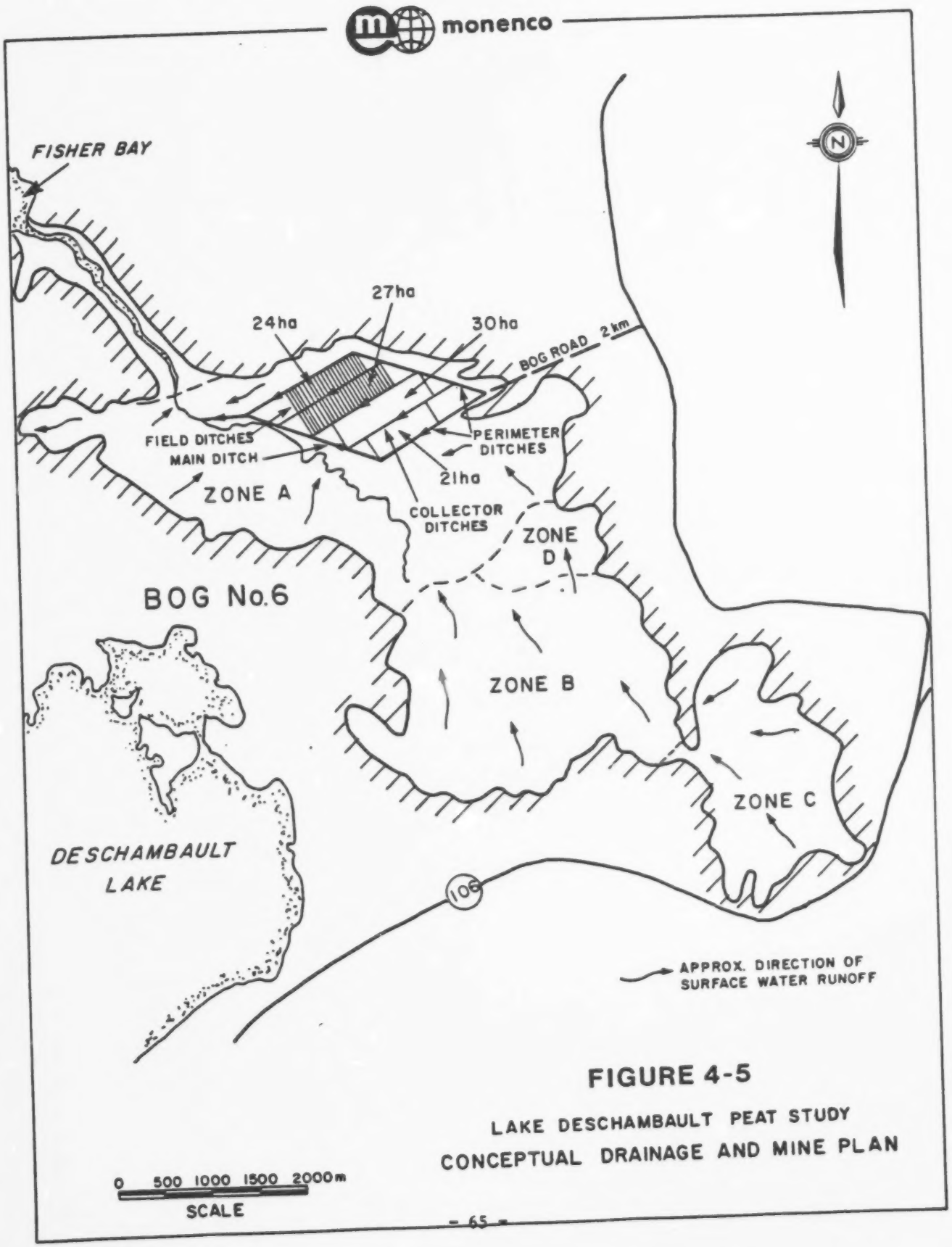


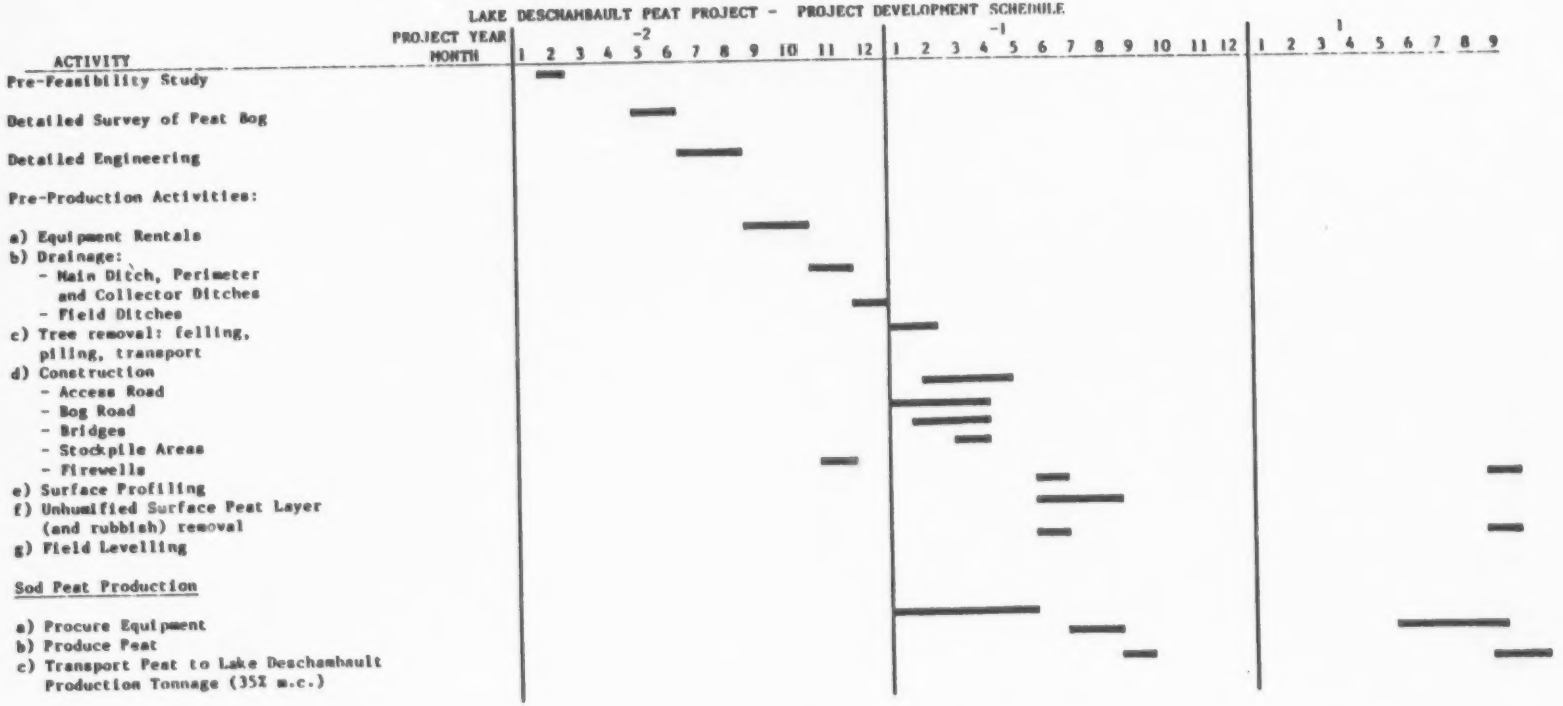
FIGURE 4-5

LAKE DESCHAMBAULT PEAT STUDY

CONCEPTUAL DRAINAGE AND MINE PLAN

FIGURE 4-6

LAKE DESCHAMBAULT PEAT PROJECT - PROJECT DEVELOPMENT SCHEDULE


ACTIVITY
PROJECT YEAR
MONTH
-2
-1
1
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9
Pre-Feasibility Study
Detailed Survey of Peat Bog
Detailed Engineering
Pre-Production Activities:
a) Equipment Rentals
b) Drainage:
- Main Ditch, Perimeter and Collector Ditches
- Field Ditches
c) Tree removal: felling, piling, transport
d) Construction
- Access Road
- Bog Road
- Bridges
- Stockpile Areas
- Firewells
e) Surface Profiling
f) Unhumified Surface Peat Layer (and rubbish) removal
g) Field Levelling
Sod Peat Production
a) Procure Equipment
b) Produce Peat
c) Transport Peat to Lake Deschambault
Production Tonnage (35% m.c.)

ENERGY OPTIONS

5.1 GRID EXTENSION TO DESCHAMBAULT LAKE

During the course of the current study, information was received from North Sask. Electric on current thinking regarding the possibilities to connect the town of Deschambault Lake to the provincial grid. Several routes to transport grid power have been briefly examined, including:

a) Extend the line which runs from Island Falls to Pelican Narrows, along highway #135 and #106 to serve the resort community of Jan Lake, plus the hamlet of Deschambault Lake.

The estimate for "line-clearing" alone for this route was $1.5 million. This option was not considered viable.

b) Tie into the grid originating at Island Falls, at Crieghton/Flin Flon and construct a transmission line approximately 155 kms. east on highway #106 to Deschambault.

The estimated cost of this alternative for line clearing and construction is $3,120,164.00 not including the cost of a "step-down" transformer at Flin Flon. This alternative is considered un-attractive for two reasons:

i) the cost, and

ii) the difficulty of getting a line out of the H.B.M. & S. yard at Flin Flon without the necessity of constructing another sub-station.

c) The currently preferred route: Sask Power compiled preliminary estimate figures for their 1987 budget year to extend a "grid reinforcement" line from Squaw Rapids into the north. One of the alternative routes by which this might be

accomplished is a route from Squaw Rapids overland to meet highway #106 at the Pasquaka Rapids, about 60 kms. south and west of Deschambault. This would be a 230,000 volt line. The estimated cost (1987 dollars) for step-down facilities (to 25,000 volts) was $765,000. Line clearing at $307,000 plus construction of 60 kms of 25,000 volt line at $890,000 brought the total estimated cost to $1,962,000.

No approvals have been obtained, and this option is dependent upon the "northern re-inforcement" proposal being accepted and this particular routing being selected. It was, however, the solution to the problem of providing Deschambault with grid power that was favoured by the planners at the time.

More recent discussions (03/84) indicate that northern demand has not increased as expected and the schedule for construction of the reinforcement line has been set back somewhat and rough costs for the step-down facilities, line clearing and the 25 kv line construction to Deschambault have increased to $2,635,000 (1984$). A decision on the routing of the high voltage (reinforcement) line has still not been made, and none appears imminent.

5.2 MINI-HYDRO OPTION FOR DESCHAMBAULT LAKE

EMR PRELIMINARY ASSESSMENT

The Conservation and Renewable Energy Office of EMR (Saskatoon) carried out a preliminary assessment of mini-hydro potential for Deschambault in December, 1983 by reviewing available literature from Saskatchewan Power Corporation (SPC) and Crippen Consultants in North Vancouver on Mini-Hydro project assessments. The SPC report provided criteria for determining the feasibility of small

hydro-electric plants for remote communities in Northern Saskatchewan; the Crippen Consultants report covered essentially the same for communities in British Columbia.

Three major criteria were identified in the previous reports as essential to small-hydro development: (1) potential head (minimum 3 meters); (2) stream flow (dependent on head); and (3) site suitability (maximum 20 miles from community). Of the 46 communities considered by SPC, topographical maps indicated that nineteen may have potential for small hydro-electric plants; Deschambault was not one of the nineteen.

The Remote Communities Overview Study (published March 1983) indicated a potential site 18 km away from Deschambault with a head potential of 2-4 meters (no stream flow rate is specified).

The capacity of a small hydro-electric unit was estimated from:

$$KW = \frac{QH}{15}$$

Where: KW is the capacity in kilowatts,
Q is the flow in cubic feet per second,
H is the head in feet

The rule of thumb used was to allow an average load requirement of 1.5 KW per person to determine capacity of the hydro-electric unit.

Using the Overview Study population figures (612) for the year 1990 at Deschambault Lake, EMR estimated the capacity required for a small hydro-electric plant to be approximately 1,000 KW. Using the formula for estimating capacity of a small hydro-electric unit and assuming a head of ten (10) feet at the Deschambault site would require a stream flow rate of 1,500 cubic feet per second (cfs) to

produce the estimated 1,000 KW capacity. EMR concluded that it would be very doubtful the selected site location would produce the 1,500 cfs stream flow.

Estimated project costs in 1982 were approximately $1,000 per KW of capacity; this included the generating equipment, transmission lines and construction of the hydro site. Using this very conservative estimate the minimum cost of a small hydro-electric site for Deschambault Lake was estimated to be $1 million dollars.

It was the opinion of EMR that the potential head and flow rate of the stream are not suitable for consideration of a small hydro-electric plant. The construction costs to develop a suitable head and consequently stream flow rate would likely make the cost of installing a small hydro-electric plant at Deschambault Lake unrealistic.

MONENCO REVIEW

Although it was beyond the terms of reference for the current study, Monenco further examined (in very preliminary detail) the possibilities for mini-hydro. A potential site was located on the 1:50,000 scale Viney Lake topographical map at 103-08 west, 54-53 north, along the eastern shore of Deschambault Lake at a location where there is a drop of about 36 feet between Deschambault Lake and Pelican Lake. Community information indicated an 18 inch fluctuation in lake level, from "high water" in the spring, to "low water" in early fall.

A project comprising a dam with a height of about 6m, crest length about 200 m and with an intake, penstock through the dam, and powerhouse with 2 x 100 kW units for a total installation of 200 kW could be realized. There would be no spillway, the water would remain flowing through the existing lake outlet and the project could be built in the dry, hence little or no cost of diverting water. A

transmission line of about 31 km in length would be required and an access road 25 km from an existing road to the south of Deschambault. A river crossing is required. Minimum cost of the generation facilities (excluding transmission) would be about $1.6 million and if the capacity were doubled to 400 kw, about $2.7 million.

However, there is another village about 30 km to the east that could conceivably benefit from a hydro installation. Although the configuration above may not supply the entire anticipated future requirements, it's use as peaking supply in conjunction with peat-fired base loading should be considered, especially if grid power is considered unlikely in the foreseeable future. It appears a more detailed examination of hydro power potential is warranted and should be the subject of any phase 2 study.

5.3 POSSIBLE PEAT UTILIZATION SCHEME

INTRODUCTION

Much of the technology described herein and, in particular, the peat-fired steam generator can also be fired with wood. It is anticipated the wood waste from the sawmill could readily be accommodated. It is expected that wood quantities would be relatively small, however, the possibility of an integrated wood/peat operation(s) should be further examined if more detailed engineering study proceeds.

Due to the reduction in study scope over the original proposal, it was not possible to study a number of peat utilization options in detail. Some which appear to have possibilities for the Deschambault Lake location are (see also Appendix 1 for manufacturers' information):

- fuel peat for domestic, institutional and commercial heating in small individual boilers,

- small district heating plant,

- small peat-fired boiler/steam engine for power generation,

- peat gasification to provide low BTU gas to fuel modified diesel engine(s), and

- non-energy uses and advanced peat technologies.

The main objectives of the current project, were to recommend possible alternatives to best meet the energy requirements of Deschambault Lake in a cost effective manner. Diesel-electric power generation is the main energy source and the village consumed approximately 75,050 Imp. gallons of diesel fuel in 1981 which was trucked in from outside at a cost of about $1.29/Imp.gal. (1981 cost). Two possibilities considered for using local fuel peat to replace "imported" oil were the boiler/steam engine and gasifier/diesel alternatives. Preliminary review of capital costs and system complexity showed a preference for the peat-fired boiler/steam engine approach for the current study.

In this part of the study, a peat burning boiler/steam engine facility is described and a preliminary budget capital cost and annual operating and maintenance cost of the facility are indicated. It should be noted that while peat-fired boilers are available in this size range there are no known applications for power generation. Therefore, while such an installation is technically feasible, further investigation is necessary.

PEAT-FIRED GENERATION STATION TO MEET CURRENT DEMAND

In order to size the peat-fired generating station, data from North Sask. Electric and DNS was evaluated. The main points of the information provided was that the peak load in 1981 was 210 kW and the annual electric consumption was 975,306 kWhrs. There was no data available as to the base load. No information was available on the costs of increased generating capacity using diesels or what the rate schedule would be in such a case. It is not expected North Sask. Electric would attempt to interconnect the existing diesels, due to age of equipment and stand-by requirements.

Therefore, a generating capacity of 250 kW (to meet current demand) was considered as a base case with the knowledge that this size of unit will not be adequate to meet future load growth, but would serve to illustrate the technology and indicate order-of-magnitude costs. The 250 kW size generating capacity is about the smallest possible and will tend to illustrate a "worst case" of unit costs of power situation since considerable economies of scale are realized, particularly in the peat mining operation, at increased size of generating capacity.

Based on the above, a generating capacity of 250 kW was estimated to meet current demand for the peat-fired unit, since:

- the peak load of 210 kW would only be encountered a few hours per day - the base load being considerably less;

- based on a consumption of 975,300 kWhr, the annual load factor for a 250 kW unit is approximately 45%, which is typical for a unit of this type;

- peat-fired boilers do not have good turndown (low load) operating characteristics, supplementary oil firing will be required to maintain stable combustion below 40-50% load.

Therefore, the benefit of a peat-fired unit would be reduced if it ran at low loads for extended periods.

In view of the disadvantages of low load operating characteristics of peat fired units, a further detailed evaluation of unit size will be required to meet future requirements, e.g.:

- One large peat fired unit, using supplementary oil firing for low load operation.

- Two peat fired units, with both operating in winter and one operating in warmer months.

- One intermediate sized peat fired unit, utilizing the existing diesels (or possibly a mini-hydro unit) for peaking.

This type of evaluation is recommended for further study, at the next phase, where analysis of load growth and generation alternatives could be studied in detail to determine the optimum scheme.

DESCRIPTION OF THE PLANT

The main features of generating stations for northern communities are simplicity of design and ease of operation and maintenance. The main sections of the plant are the peat receiving and handling equipment, the boiler complete with auxiliaries and the steam engine/generator set. A simplified flow sheet is included (See Figure 5-1) to show the major components of the system which are described in the following sub-sections.

PEAT RECEIVING AND HANDLING EQUIPMENT

The peat is delivered to the generating station by truck and discharged directly into the receiving silo. The receiving silo is designed for a capacity of 24 hours at full load. This ensures that the peat is only delivered once per day. It is also possible to enlarge the receiving silo to enable sufficient storage for a long weekend.

A peat yard storage stockpile will also be required at the generating station site. In the case of an interruption of the fuel transportation by trucks, the solid fuel will be taken from the stockpile and transported to the storage silo by a wheel loader. Regular cycling of yard storage will be required to preserve fuel quality. Also, peat delivery and storage during winter months must be considered to avoid problems associated with handling frozen peat sods; however, no cost is included for this item in the estimate.

The receiving silo will be fitted with a positive discharge conveyor which will feed the furnace feeding conveyor. At the furnace, the peat will be discharged into a feeder hopper which will be equipped with an air lock rotary feeder for fuelling the furnace.

The peat handling system from the receiving silo to be furnace feed will operate automatically in response to load demand.

PEAT-FIRED BOILER AND AUXILIARIES

The boiler's stable operating range burning peat is expected to be from 100% down to 40-50% of full load rating. Lower loads can be accommodated with supplementary oil firing.

From the rotary feeder, the peat fuel will be fed to a sloped adjustable mechanical grate. The refractory lining, ash grate, and

the ash clean-out system will be designed to withstand sod peat combustion and ash based on previous experience.

The furnace will be designed for under-fire primary air provided by a combustion air fan. Start-up and low supplementary oil fuel will be the diesel fuel presently available on site.

The steam generating section of the boiler will provide saturated steam in sufficient quantities to operate the steam engine.

The flue gas system which includes a dust collector, I.D. fan and stack will provide sufficient cleaning to meet environmental requirements.

The ash clean-out system will discharge the ash into a bin which will be cleaned periodically and disposed of by truck. Brochures for typical boilers are included in this report for information.

STEAM ENGINE/GENERATOR SET

The steam provided by the boiler will be used to power the steam engine/generator set. For such a small unit, a vertical double acting machine is sufficient. A brochure for a typical steam engine is included in this report for reference.

All necessary steam control and generator controls associated with the generating set are provided.

Also included are the associated steam/water components which include an inlet steam separator, an exhaust oil/steam separator, a barometric condenser, condensate hotwell, pumps, etc. It is assumed

that sufficient water is available at the site for make-up and cooling requirements.

DESIGN AND OPERATING CRITERIA

Preliminary estimates of some of the pertinent design and operating criteria associated with the generating station are as follows:

Generator output:	250 kW
Steam required:	1.134 kg/s (9,000 lbs/hr), 1035 kPag (150 psig), saturated
Maximum peat burn rate:	.353 kg/s (2,800 lbs/hr)
Annual peat requirement:	4990 Mg (5,500 tons) (assuming 45% load factor)

As-received peat characteristics:

Moisture content:	40%
Heating value:	12,696 kJ/kg (5,460 Btu/lb)
Bulk density:	340 kg/m^3 (21.2 lb/ft^3)

COST ESTIMATE

As well as all the equipment described in the previous section, other components included in the cost estimate are site improvements, building, foundations, and electrical equipment to

tie-in to existing grid. The capital cost does not include engineering and other indirect costs. The budget estimate for the installed plant is $1,000,000 (end of 1983 dollars).

The annual operating and maintenance costs allow for 3 shifts per day, each shift manned by one operator, and one mobile equipment operator/general maintenance man one shift per day. It is assumed that North Sask. Electric would supply qualified personnel for major repairs (as is currently the case for the diesel generators). An estimate for the annual O&M cost is $250,000.

OTHER CONSIDERATIONS

The steam engine/generator set, as described and estimated in the previous sections, was selected due to its simple design and reliability. One method of maintaining the same system design but decreasing the initial cost is to purchase a used steam engine. The Ontario Ministry of Energy has been investigating this situation, and they estimate 35-40 machines are being discarded each year. If a suitable machine could be located, the potential savings in capital cost could be as much as $150,000; however, since the machine would be relatively old, the reliability and maintenance aspects are questionable. Since the project is for a northern community, reliability is a main consideration, therefore the purchase of a used steam engine is not recommended in this current study. However, a more detailed study or a demonstration project should be considered in the future.

This study has arbitrarily chosen a boiler/steam engine generator set as one possibility for producing electricity from peat at Lake Deschambault, however, such an installation must be considered as state-of-the art. Even though solid fuels such as peat have been under much study for the past few years, we are not aware of any similar installations in North America. There are numerous

installations in Europe where peat fuels have been exploited for power generation and heating systems. If the utilization of peat in the Lake Deschambault area progresses to further stages of study, the proven technologies must be carefully examined and evaluated for the severe conditions in northern Canada.

5.4 COSTS OF PEAT-FIRED POWER GENERATOR

250 KW PLANT SIZE

The mining and transporting cost for sod peat as delivered to the plant site is about $4.06/MMBtu. Considering the heat rate of the boiler/steam engine plant, the cost translates to about $76.60/MMBtu electrical or about $0.27/kWhr, electrical. To this cost must be added the capital and operating costs of the new boiler/steam engine generator set. Including costs for recovery of capital at a 12% interest rate, an allowance for working capital, yearly O & M costs as described earlier, and a 20 year operating life, the costs of a new peat-fired boiler/steam engine generating facility will be about $0.40/kWhr, based on the output assumptions as discussed in Part 4. Total costs expressed in terms of electrical output at expected load are about $0.67/kWhr which is much higher than the current costs of existing diesel-electric power generation at the 250 kW level.

500 KW PLANT SIZE

North Sask. Electric has indicated that if a new diesel unit were installed at this time, it would be in the 600-800 kW size range. No costs were given. Further study would be required to develop capital and operating costs and/or obtain unit costs of power for a new, larger 500 kW diesel generating facility. An indication is given below of unit costs of power generation (the unit power rates

calculated include recovery of capital and operating costs) for a peat-fired plant. At increased capacity the peat-fired facility becomes somewhat more cost effective.

The mining facility at 5100 tonnes/year is at minimum capacity for the equipment set and for a relatively small incremental increase in capital and operating costs is capable of a production level of about 9,000 to 10,000 tonnes per year. It is estimated that the cost of peat delivered to the plant site stockpile would reduce approximately 35% to about $0.18 per kWhr, electrical (late 1983 $) at this higher production rate.

The increased peat supply would be sufficient for a doubling of capacity of the peat-fired generation facility to about 500 kW. For 2 x 250 kW units it is expected the capital costs would nearly double and the operating and maintenance costs would also increase. Assuming total electrical consumption also doubled, the unit production costs of the generating facility (excluding fuel) would be about $0.40/kWhr. Total unit costs of electrical power then reduce to about $0.58/kWhr compared to the single 250 kW unit at $0.67/kWhr.

If a single 500 kW plant were considered then capital costs increase less (about 40-50%) and O & M costs also less (about 10%) for the same doubling of output and result in a further lowering of total power production costs to $0.43/kWhr. The above calculations assume that sufficient load would exist to avoid significant oil injection for flame stabilization.

The aforementioned costs indicate the economies of scale associated with a peat-fired generating option. It is expected further increased consumption would further reduce the costs of generation. However, the spread between current costs of power to the community using diesel and the peat-fired costs is substantial and it appears that the peat utilization option selected for consideration

cannot be competitive with the existing diesel-electric facility (which presumably is a sunk cost), solely on a cost of power generated basis. However, data on the costs North Sask. Electric would charge for power from a new diesel electric facility was not available.

SOME SOCIO-ECONOMIC BENEFITS OF A PEAT-FIRED FACILITY

Although costs of power generation by peat appear high, it is possible they may be offset somewhat by certain socio-economic benefits of a peat-fired facility should be considered before possible rejection of the peat-fired option. The possibility of federal assistance in the capital costs of implementing a selected project would influence the resulting energy charge rates. Some realistic socio-economic benefits could include:

- seasonal employment for 4-5 labourers/equipment operators, and 2-3 supervision personnel at the mine site,
- a one to two month truck haulage contract for 1 or 2 tandem trucks,
- employment for 4-5 personnel at the boiler plant facility, some personnel on a year round basis,
- displacement of diesel fuel currently in use by the diesel-electric plant, and
- the multiplier effect of a new, local small industry, and
- possible uses for waste/supplementary heat.

The reader is referred to a study entitled "Assessment of the Technical and Economic Feasibility of Peat Resource Development in Northern Saskatchewan Communities" by Monenco (Saskmont) in 1979 where

a number of possible applications for fuel peat are outlined including greenhouse heating. A very preliminary examination shows that it may be possible to capture waste heat to supply a greenhouse requiring a heat input of several million Btu's/hour from the 250 kW generating facility, providing the unit is running at near maximum operating conditions. It was noted in the 1979 report that an existing greenhouse in Prince Albert (about 1 acre in size) was growing tree seedlings. Another greenhouse in Saskatoon was reported to grow vine-ripened tomatoes which obtained a premium price (10% higher) over imported tomatoes. Considering the distance to haul fresh product to Deschambault, it is expected that the local greenhouse application may be of considerable interest. Of course, local existing and anticipated consumption of greenhouse product and costs associated with a greenhouse operation would have to be examined in detail.

The peat mining operation is expected to remove a relatively large amount of unhumified peat, prior to starting actual fuel peat mining, that is expected would be suitable for greenhouse purposes.

5.5 OTHER PEAT-FUELED TECHNOLOGY

A peat gasifier and diesel engine system is reported at the commercialization stage in Finland (see Appendix 1). Tests have been carried out in which peat and wood have been gasified and the gas used as a fuel in a medium speed diesel engine. Oy Wartsila Ab in Finland is currently marketing this concept based on test runs carried out during 1982 at the town of Kotka in Finland. The equipment has been designed for the 5-25 MW electricity and heat range. The supplier gave cost information for a 2 MW plant which was quoted to be about $5 1/2 million on a turnkey basis. Other sources of this equipment are not known and previous examinations of this technology by Monenco indicated considerable development work on the gasifier and modification of the diesel engines would be required to develop a 250 kW unit using North American equipment.

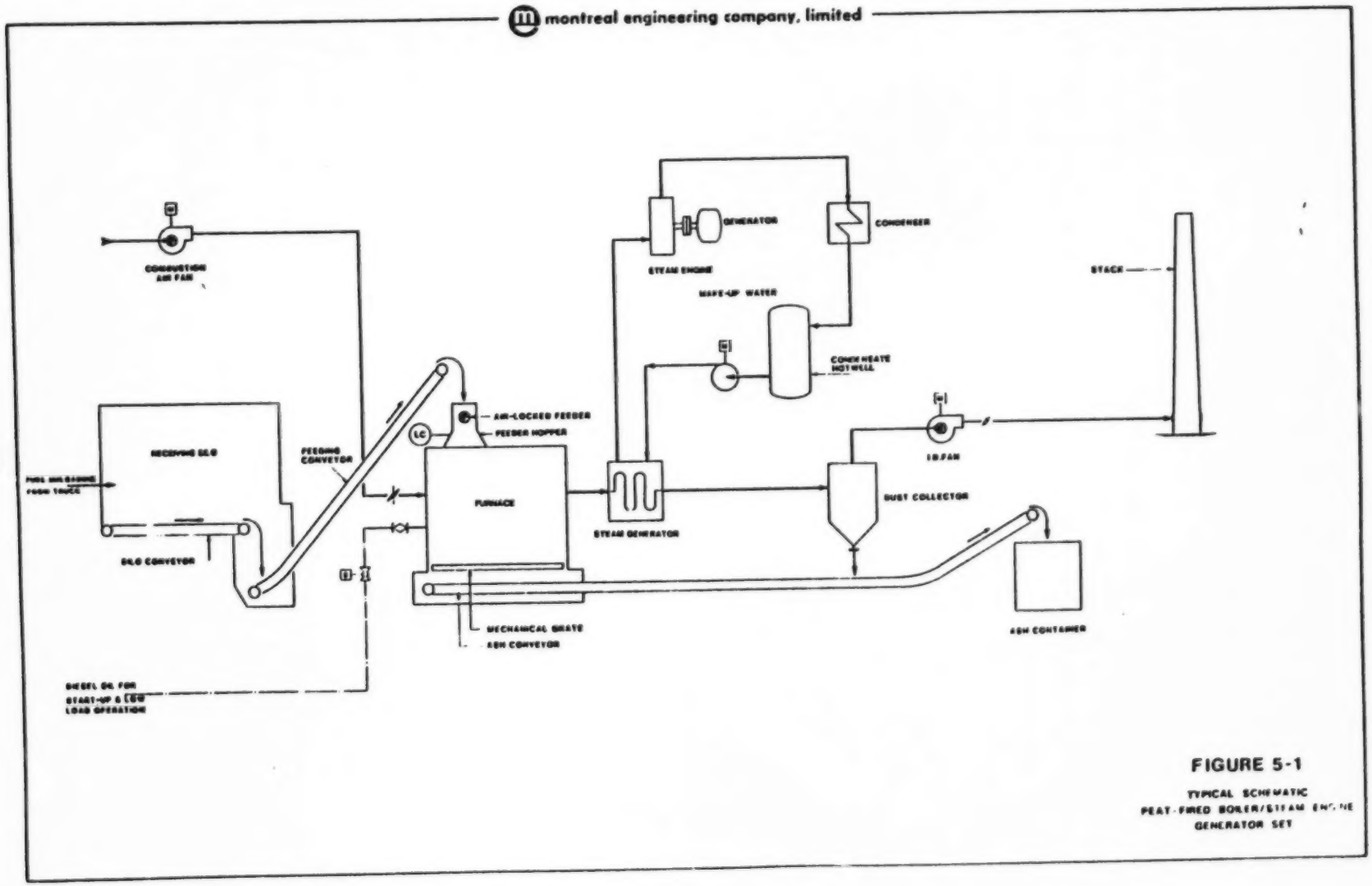


FIGURE 5-1

TYPICAL SCHEMATIC
PEAT-FIRED BOILER/STEAM ENGINE
GENERATOR SET

DISCUSSION OF ENERGY ALTERNATIVES

The current study appeared rather straightforward at the outset, however, as the investigation progressed a number of interesting alternatives arose and questions were raised, particularly regarding electrical rates for northern consumers. The following discussion is somewhat "free wheeling" but has been included since it raises a number of points of particular interest to northern residents and includes a number of comments from the local consultant to the project.

Electricity from diesel generators provides the bulk of the energy requirements in the community of Deschambault. High unit costs of diesel generated electricity are a major concern to both residential users and local government agencies. Because of the seasonally low load, there is no clear evidence of an alternative to lower the costs of generating power than currently exists, but demand is growing and additional capacity is required.

The schedule of rates for communities on diesel power is structured so as to recover the costs of operating the diesel generating system. High operation and maintenance costs are spread over a small number of communities (ten, small remote communities) who do not have the opportunity to share the benefits of economies realized from spreading costs across the entire provincial grid network.

A large portion of operating costs is recovered from electrical service charges to federal, provincial and local government agencies. The Federal government, through its share of operating expenses for the school and health centre, contributes substantially to the cost of electrical power generation locally.

A number of factors over which they have very little control are working to increase the electrical costs to many residential

consumers. New housing consumes electricity at near triple the rate of consumption for old housing. The "disincentive" rate schedule severely penalizes large volume residential consumers. The only rationale for the "disincentive" rate structure applied to residential consumers, is to limit consumption in instances where generating capacity is limited.

Any solution to the problem of limited generating capacity at Deschambault Lake, whether it be connection to the Provincial grid, or some alternate solution, should result in the application of the provincial grid rate structure.

Given that the communities concerns regarding the high cost of electricity might be resolved, the question now becomes how might the utilities company ensure the provision of an adequate supply of electrical power, by the most cost effective means, which takes account of the social and economic circumstances of the region (community) served.

It is evident from the many questions the current study has raised that final recommendations will reflect outstanding answers on a number of points, including:

- the likelihood of construction of the grid "reinforcement" line in the foreseeable future,

- the actual availability of the mini-hydro source, its actual size and more details on construction costs,

- the costs of an expansion of the diesel facilities,

- the possible utilization of waste heat from the peat-fired boiler and the costs of the heat recovery system,

- further refinement of peat-fired generation costs at higher capacity - the peat deposit studied had a relatively thick unhumified layer and further investigation may result in locating a better deposit (for mining purposes).

To satisfy the power demand that will exist in the 1990's (up to 1 MW), additional generating capacity will be required which is expected to vary from two to four times current consumption levels. Insufficient evidence currently exists to clearly point out a "front-runner" in terms of energy options for Deschambault. Sufficient information has been gathered which does demonstrate that several viable alternatives do exist. Due to the potential overall socio-economic benefits, it is recommended that a second phase feasibility study proceed to develop more information on the peat-fired option, in terms of alternative mining sites, optimum size of generating plant and mining operation, waste heat recovery system and utilization and cost benefits of same, more detailed analysis of meteorological conditions and consideration of project implementation methods (including structure of the operating company and employee training). Such a second phase study would include as the first steps, further definition of the "grid extension" option and the possibilities of mini-hydro (for use either as a primary supply or for peaking purposes).

SUMMARY AND CONCLUSIONS

1. Local residents are concerned about the high costs of energy and increasingly this situation is affecting larger numbers of households partly because, since 1980, the new housing stock has been constructed to standards which require more energy input.

2. The current schedule of rates applied to Deschambault Lake is designed to allow consumption of up to 315 kwh/month at rates comparable to grid customers. However, above this consumption rate, a strong cost "disincentive" is in effect to discourage higher electrical usage, because of the limited generating capacity available.

3. An analysis of energy demand by 1995 for Lake Deschambault was carried out by the study team supplemented by information from North Sask. Electric. It shows that electrical consumption (about 900,000 kwh during 1982) is expected to increase to about 2 million kwh/yr assuming more or less natural factors such as population increase, new housing stock, light industry needs, etc. Electrical consumption is estimated to increase to about 4.2 million kwhr/yr by 1995 (estimated by North Sask. Electric) considering growth in the housing stock and commercial load growth with the major impact expected from changing the rate schedule to the provincial norm.

   It is evident that the capacity of the current diesel equipment will soon be inadequate to meet demand.

4. The preliminary examination of wood resources shows that there appears to be a sufficient supply of wood within a reasonable radius of the village to supply a central energy plant. Costs of harvesting have been determined very approximately by the

sub-consultant and were shown to range from about $22/odt for a fully mechanized operation to about $100/odt for a saw and skidder operation.

5. A brief reconnaissance survey of peatlands in the area was carried out; 8 sites were visited. One bog (No. 6) in particular was identified as a potential source for fuel peat production. The peatlands are large; No. 6 is 2000 ha of which about 1000 ha has an average depth greater than 1.5 m. The potential mineable resource from this deposit is about 1.7 million tonnes, air-dried to 35% moisture content. The calorific value of a sample taken from this deposit was 8740 Btu/lb (0% moisture content), standard fuel peat quality.

6. Climatically, it appears conventional peat mining is possible at Deschambault Lake. To more accurately assess yields in terms of tonnes of air-dried run-of-mine fuel peat product, further work on the meteorological aspects will be required. Indications are that at least one cycle is possible and likely two in most years.

7. Peat mining costs were determined and are somewhat higher than in more southerly locations and also reflect some conservatism regarding yields. Mining costs for a 5100 tonne/year operation were shown to be about $52/tonne delivered to the plant. Cost decreases considerably due to economies of scale for the 10,000 tonne/year operation to about $35/tonne.

8. Several energy options were considered in this study, including:

   - a possible grid extension to Deschambault Lake,
   - mini-hydro, and
   - various configurations using wood and peat.

Regarding the grid extension, several assumptions were put forward including the possibilities that if a grid connection were made, the residents of Deschambault would receive standard provincial electricity rates and the costs of the constructing the transmission line would be borne by the rest of the system or paid for by the Province. It has also been considered that costs of transmission line construction could be recovered in the rates charged consumers at Deschambault Lake. Which alternative above (or none) is considered, impacts significantly on the analysis of the possible implementation of the other options. Resolution of the above questions is beyond the scope of the current study but should be resolved at the initial stage of any Phase 2 follow-up work.

Regarding mini-hydro, Monenco very briefly reviewed the topographical maps of the area and located a possible site which (without control of the current lake outlet), considering a lake level fluctuation of about 18 inches, would be sufficient to operate a 200-400 kw mini-hydro generator. This option should be considered and reviewed in the early stages of any follow-up, more detailed, engineering studies. A combination of the peat-fired system, with the use of mini-hydro for peaking, may prove to be an interesting alternative, particularly to supply future demand.

A peat-fired steam engine/generator was selected as a possible electrical energy option for Deschambault Lake, considering the small scale involved. A 250 kW unit was selected, sufficient to meet the current energy demand (and also because of the low load characteristics of the peat-fired unit), and would also illustrate the technology and costs. The overall efficiency of the system is rather low, but the technology is relatively simple and has been used for other purposes. Further detailed work would be required to examine the technology considering the conditions prevailing at Deschambault Lake. The 250 kW size

represents a "worst case" scenario for peat, particularly because the size of mining operation results in under-utilization of some of the equipment. Costs reduce considerably at the 500 kW capacity level due to economies of scale, but could not be compared to diesel since diesel costs at 500 kW were not available and would have required effort beyond the study scope.

Total costs of power generation by 250 kW diesel are currently $0.21 /kwh (1982). Costs in 1980 and 1981 were $0.155 and $0.18/kwh respectively. The peat-fired steam engine/generator at 250 kW capacity is expected to cost $0.67/kwh, significantly higher. At the 500 kW level, the peat-fired costs were $0.48/kwh for 2 x 250 units and $0.43/kwh for a single 500 kW unit. The peat-fired unit alone cannot generate power cheaper than the existing diesel plant, at the 250 kW level.

9. The socio-economic benefits of a peat-fired facility should not be overlooked in terms of employment, use of a local natural resource (i.e. displacement of oil) and the possibility of waste heat recovery to supply, e.g., a greenhouse operation, laundromat, etc. Further examination of the waste heat recovery system and associated costs is required before any cost benefit can be determined.

10. Low cost power is a prime objective for Deschambault Lake residents. It appears the only way to achieve this objective is by application of the standard provincial rate structure. It is recommended that this approach be considered, regardless of the energy option chosen. Energy options should then be evaluated solely on the basis of the best overall economic and social return to the community. It is expected that an option which

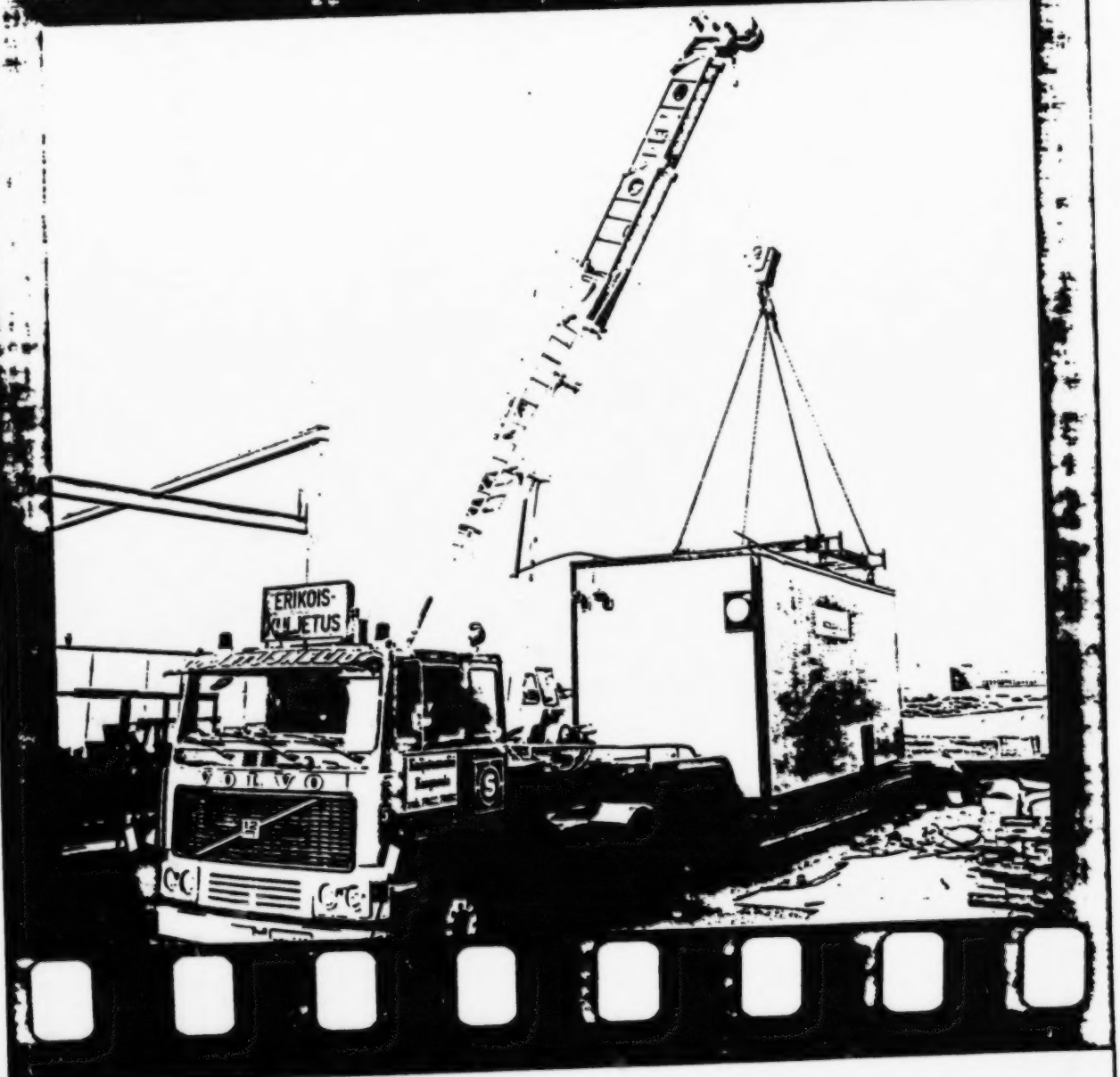
will demonstrate community involvement in solving local energy needs (perhaps with assistance in the form of a corporate structure and training) should be carefully reviewed.

11. Further analysis is required to select the "best" energy option for Deschambault Lake.

APPENDIX I

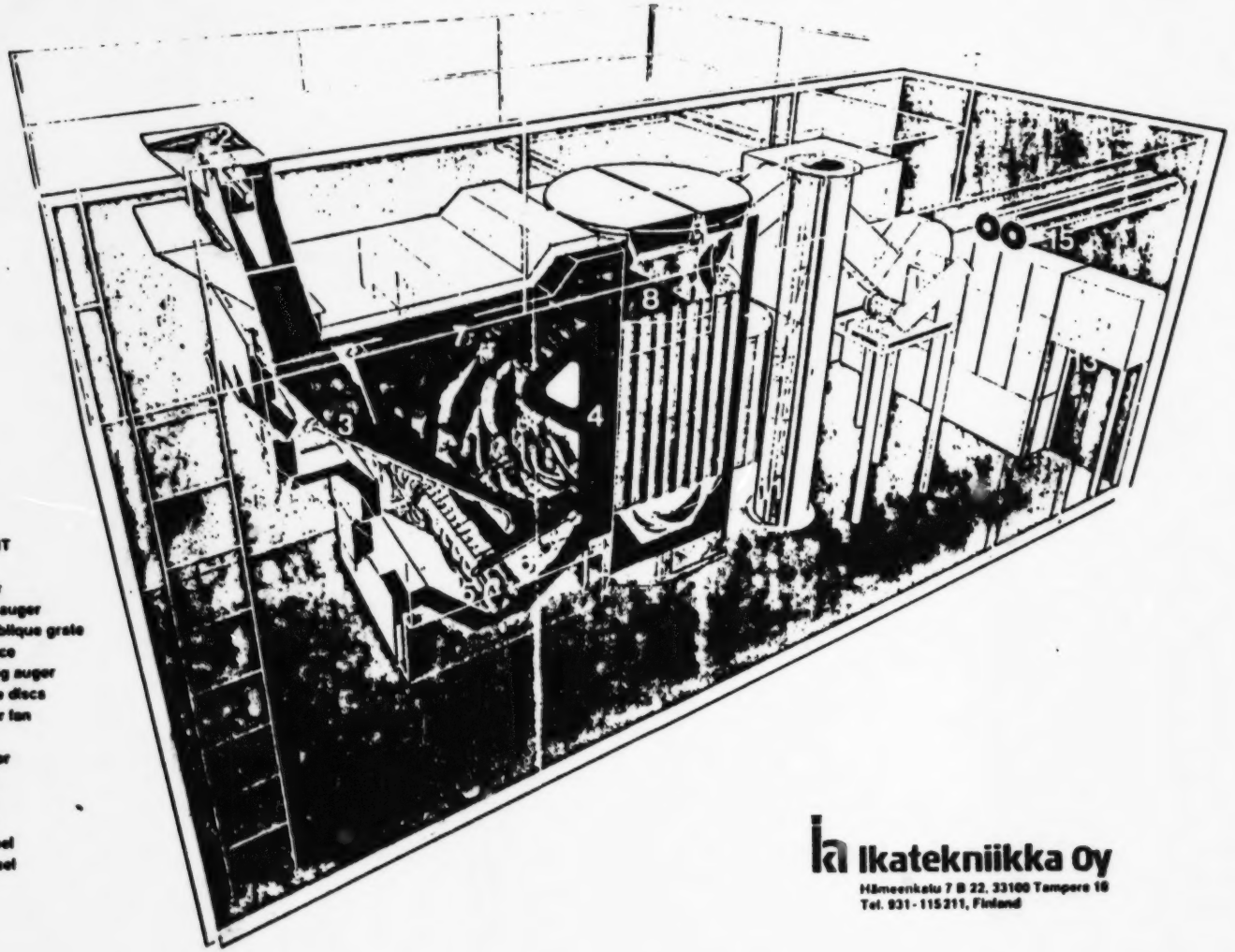
MANUFACTURERS INFORMATION

LET UNITS WHICH USE SOLID FUELS, HELP YOUR ENERGY PROBLEMS, TOO.



ka Ikatekniikka Oy

Hämeenkatu 7 B 22, 33100 Tampere 10
Tel. 931-115211, Finland



IKA-HEATING UNIT

1. Feeding hopper
2. Fuel spreading auger
3. Water cooled oblique grate
4. Recovery furnace
5. Ash transporting auger
6. Mecanical grate discs
7. Combustible air fan
8. Boiler
9. Flyash separator
10. Flue fume fan
11. Smoke stack
12. Control panel
13. Instrument panel
14. Expansion vessel
15. Pipe lines

Ikatekniikka Oy
Hämeenkatu 7 B 22, 33100 Tampere 10
Tel. 931-115211, Finland

IKA RESULT OF LONG DEVELOPMENT.

Possibilities for solid fuel heating units.

National energy saving standards of production are required at all levels of building construction starting from private house to large factory installations.

The heat production must be based on the possibility of a short haulage of solid fuels.

Heating units for rough solid fuels are suitable for a wide sector:

- gardens
- farms
- schools
- communal centers
- large apartment units
- industrial installations
- sawn timber drying units to name just a few examples.

IKA-units offer a choice of units that range from 0,2 to 6 MW.

The recovery furnace, which IKATEKNIIKKA has planned, can be adapted to old heating units and in this way widen the use of solid fuel.

Fuels suitable for heating units.

Solid fuels usually have a high moisture content. Therefore IKA-recovery furnace is well planned to create even burning.

As a result of a long study we have decided to use the sliding grates in IKA-recovery furnaces to obtain the best results in high moisture fuel combustion. In this kind of a recovery furnace the following types of fuels can be used:

- saw dust
- waste woodbark
- wood chips
- green wood chips
- peat cobs
- cobs formed by compound mixture of peat, sawdust etc.

Advantages of using solid fuels:

With the raising of the oil price the use of solid fuels has become more important than ever. The price change has altered the situation in favour of using solid fuels so that whenever heating centers are needed, you have to consider very carefully the alternative of solid fuel heating plant.

The public sector gives aid in various ways to help to overcome the problems involved in the energy saving program. This aid is given to the construction of new building projects but also repairing activities and investing heating systems using solid fuels.

IKA-heating unit.

IKA-heating unit includes a boiler with a recovery furnace, a smoke stack, flyash filters and fans, a system for removing ashes, pipe lines, pumps and an expansion vessel and also an electrical and instrument systems, all ready assembled. This system complies with the national legal requirements.

We deliver complete assembled units from 0,2 to 2,0 MW, larger units are transported in parts.

The choice of a heating system.

The points to consider concerning IKA-heating systems are as follows:

- fuel suitability
- degree of automation
- service and maintenance
- reliability

In IKA-heating units components can be planned according to individual customer requirements. In this way we hope to achieve a friendly and understanding customer manufacturer relationship.

Ikatekniikka Oy

Hämeenkatu 7 B 22, 33100 Tampere 10
Tel. 931-115211, Finland

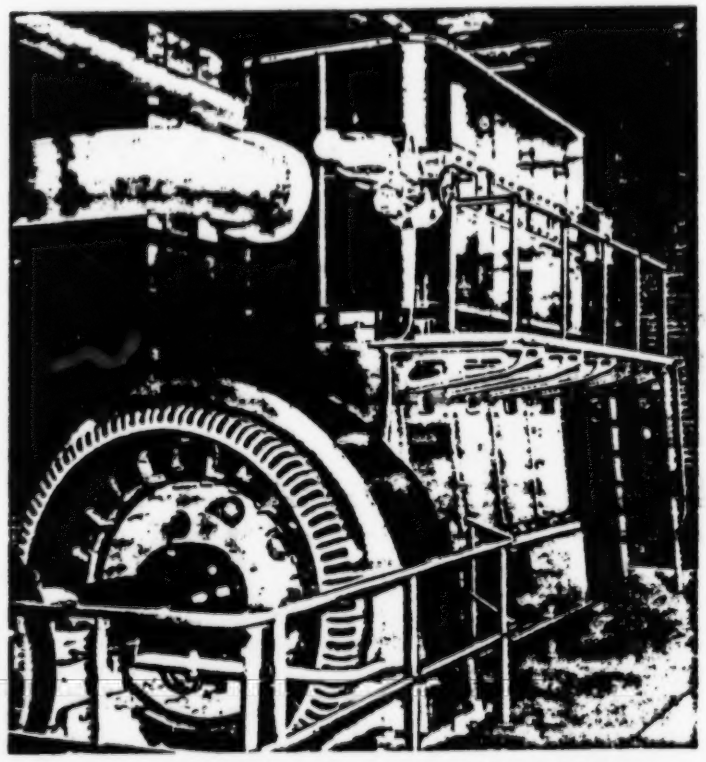
Bulletin: STE-1280

SKINNER

UNIVERSAL UNAFLOW STEAM ENGINES

MULTI-CYLINDER • VERTICAL TYPE

AVAILABLE SIZES:
300
TO
15,000
HORSEPOWER

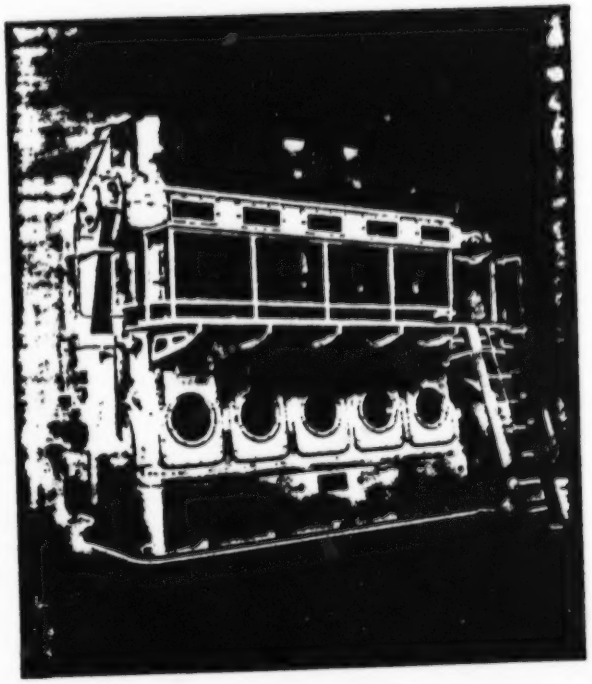


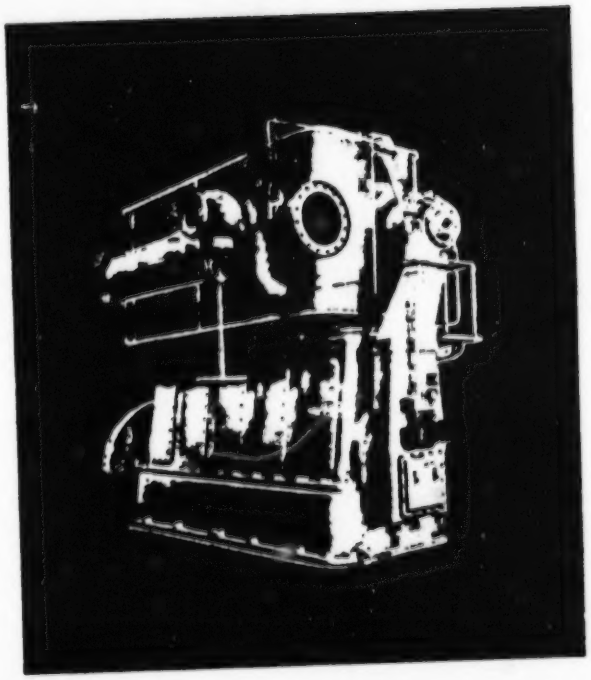
FOR INDUSTRIAL AND MARINE APPLICATION

- MAINTAINED ECONOMY
- HIGH DEPENDABILITY
- LOW MAINTENANCE COST
- MAXIMUM ACCESSIBILITY

Progress Through Performance . . . That's SKINNER

SKINNER A WORD ABOUT STEAM ENGINES . . .





With todays energy needs, SKINNER "UNIVERSAL UNAFLOW" Steam Engines of the Multi-Cylinder Vertical Type can provide unfailing, dependable power . . . to generate electricity . . . to drive compressors and pumps . . . in refrigeration and air conditioning . . . for hundreds of manufacturers (including: saw mills, sugar refineries, furniture plants, incinerator sites and petrochemical processing), office buildings, hospitals, schools and institutions.

Ideally suited where limited space conditions exist. For noncondensing or condensing operation, with automatic change for either condition. Built for constant or variable back pressure; medium or moderately high initial pressures, saturated or superheated steam.

Low pressure exhaust steam - a by-product of the steam engine - is usable for space heating, water heating, absorption type air conditioning, and a variety of manufacturing processes.

FRONT COVER PHOTO

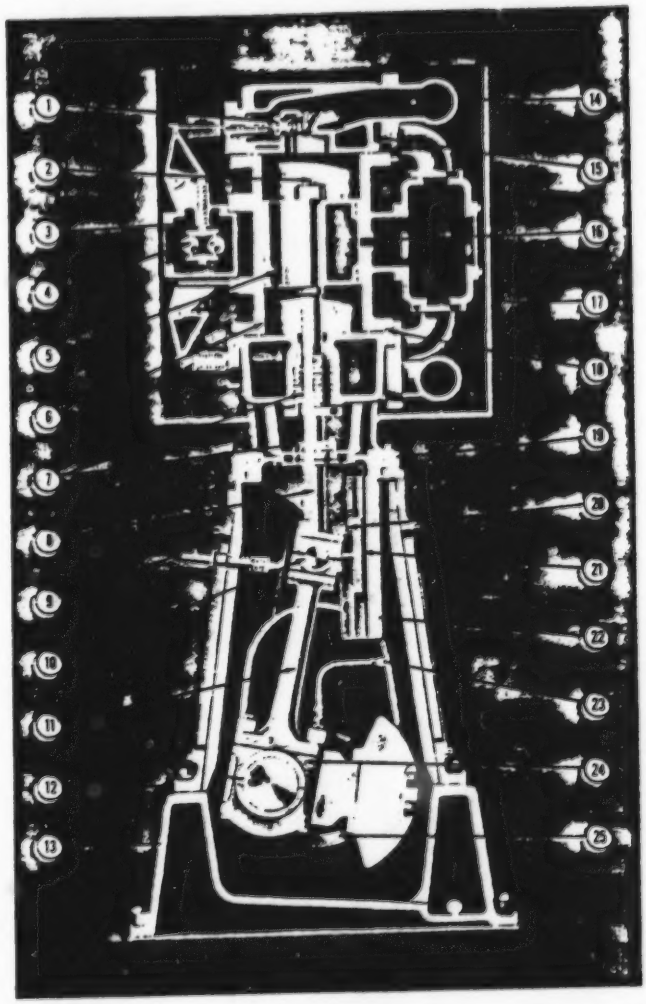
In continuous operation since 1950, one of six 1250 - kw — (4) cylinder "Universal Unaflow" Engines, in furniture plants of one manufacturer.

Progress Through Performance . . . That's SKINNER

VERTICAL "UNIVERSAL UNAFLOW" STEAM ENGINE

SKINNER

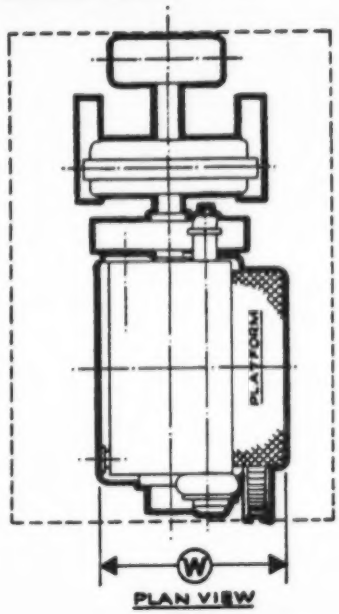
1. Steam-tight admission valve (at each end of cylinder). Double-seat. Permanently tight, regardless of variation in pressure and temperature.
2. Positive piston rod lock.
3. Pressure lubrication of all cam mechanism.
4. Dual camshafts for accurate timing and positive control of lead and cut-off. All cams, rollers and gears are hardened and ground to close tolerances. Rollers have line contact on cams.
5. Two-piece high-tensile iron piston. Eliminates troublesome core plugs.
6. Alloy iron cylinder, non-warping. Barrel-bored to compensate for expansion due to temperature gradient.
7. Steam packing (top) and bulkhead packing (bottom) with special bronze rings.
8. Forged alloy steel piston rod, ground to fine finish.
9. Permanent indicator reducing motion, with detent, for each cylinder. Permits taking indicator cards at any time without stopping engine.
10. Crosshead and pins, single-piece high-carbon steel forging.
11. Forged steel connecting rod, forked at upper end to reduce height, with heat-treated fitted bolts.
12. Box steel frame provides rigidity and total enclosure for cleanliness.
13. Rigid base, single-piece steel, double-wall construction.
14. Steam piping, and manifold (not shown), designed to permit expansion.
15. Steam-jacketed cylinder head.
16. Ample exhaust port area and manifold.
17. Steel cylinder jackets with polished steel bands and 85% magnesia cylinder lagging.
18. Permanent double ground joint—no gaskets.
19. Concentric rabbeting of guide, bottom head and cylinder to insure permanent alignment of unit assemblies.
20. Heat-treated alloy steel bolts, ground to size and accurately fitted to line-reamed holes.



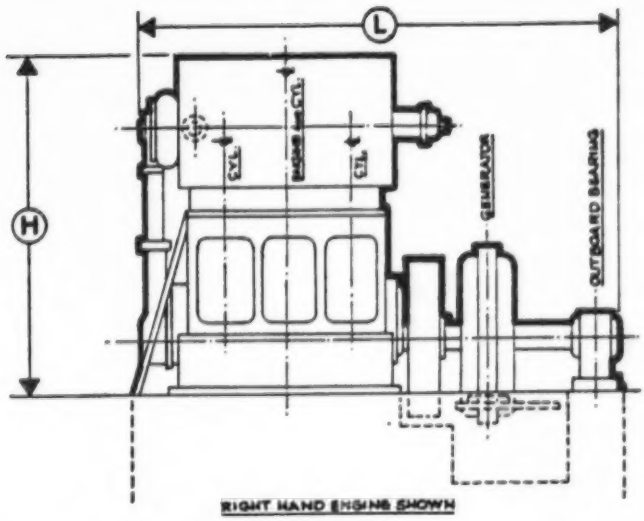
21. Crosshead shoe with tin-base babbitt top and bottom.
22. Bored crosshead guide, concentric with and parallel to the cylinder bore regardless of temperature changes.
23. Full force-feed lubrication through drilled crankshaft, connecting rod, crosshead pins and crosshead shoe.
24. Crank box, cast steel, lined with tin-base babbitt.
25. Bearing shell removable by rolling out.

Progress Through Performance . . . That's SKINNER

STEAM ENGINE DESIGN DATA



PLAN VIEW



RIGHT HAND ENGINE SHOWN

ELEVATION VIEW

STEAM ENGINE TYPE			RV - FRAME (17" STROKE)		CV - FRAME (14" STROKE)		DV - FRAME (16" STROKE)	
NUMBER OF CYLINDERS			RV - 2	RV - 3	CV - 2	CV - 3	DV - 2	DV - 3
INDICATED HORSEPOWER		IHP	425	650	770	1150	980	1500
KILOWATT		KW	275	425	500	750	600	1000
ENGINE		RPM	400		380		327	
WEIGHT - ENGINE		LBS	29,000	40,000	44,000	50,000	49,000	62,000
WEIGHT - GENERATOR		LBS	6,200	8,600	9,500	11,500	11,000	15,000
WEIGHT - FLYWHEEL		LBS	7,000		7,000		10,000	7,000
DIMENSIONS (INCHES and MILLIMETERS)	WIDTH	Ⓦ	74/1880	76/1930	76/1930	84/2134	94/2388	
	LENGTH	Ⓛ	144/3658	176/4470	172/4369	204/5182	181/4597	211/5359
	HEIGHT	Ⓗ	116/2948		138/3505		151/3835	
	CTR. SHAFT to FLOOR LINE		18/457		24/610		24/610	
	PISTON ROD REMOVAL SPACE		30/762		33/838		35/889	
	FLYWHEEL SIZE	INCHES ONLY	70 x 10		70 x 10		70 x 15	70 x 10
	OUTBOARD BEARING	INCHES ONLY	7 x 13		7 x 13		8 x 15	10 x 18
STD. FOUNDATION, CU. FT.			700	840	1200	1350	1350	1500
DEPTH STD. FOUNDATION, FT. (MM)			5 (1524)		6 (1829)		6 (1829)	

REFER TO FACTORY FOR STEAM CONDITIONS and REQUIREMENTS OTHER THAN THAT LISTED IN ABOVE TABLE.

NOTE: SINGLE and DUPLEX ENGINES OF THE PISTON VALVE TYPE AVAILABLE IN BRAKE HORSEPOWERS FROM 13 to 300. PRICES and DESCRIPTION UPON REQUEST.

30", 34", 36", 38" and 40" STROKE ENGINES ARE AVAILABLE. CHECK SKINNER ENGINE COMPANY

APPX. WATER RATE per KILOWATT HOUR
(DRY and SATURATED)
• TYPICAL EXAMPLES •

150 psig Inlet - 0# Back Press. - 31.7#/Kw.Hr.
150 psig Inlet - 12# Back Press. - 37.5#/Kw.Hr.
150 psig Inlet - 26" Vacuum - 21.7#/Kw.Hr.

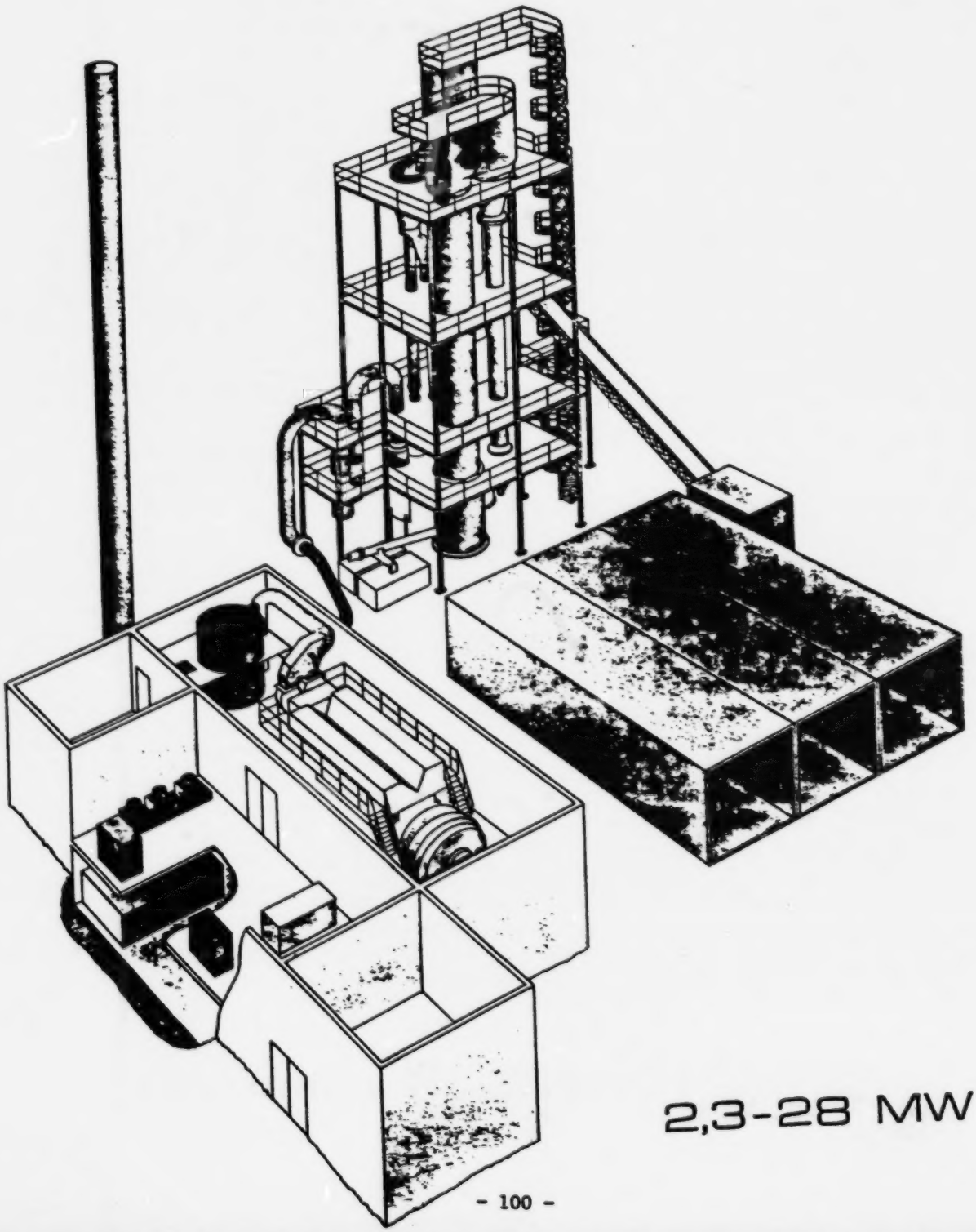
300 psig Inlet - 0# Back Press. - 27.5#/Kw.Hr.
300 psig Inlet - 12# Back Press. - 30.0#/Kw.Hr.
300 psig Inlet - 26" Vacuum - 21.2#/Kw.Hr.

SEE BULLETIN STE-477 FOR STEAM ENGINE GENERATING SETS (ENERGEN - PAC) 4" TO 10" STROKE W/BRAKE HORSEPOWER TO 300.

SKINNER ENGINE COMPANY POWER DIVISION
A SUBSIDIARY OF BANNER INDUSTRIES, INC.
P.O. Box 1149, Erie, Pennsylvania 16512
Phone: 814-454-7103 • Telex: 91-4481

PRINTED IN U.S.A.

Diesel Power From Biomass



2,3-28 MW

DIESEL POWER PLANT USING BIOMASS FUEL

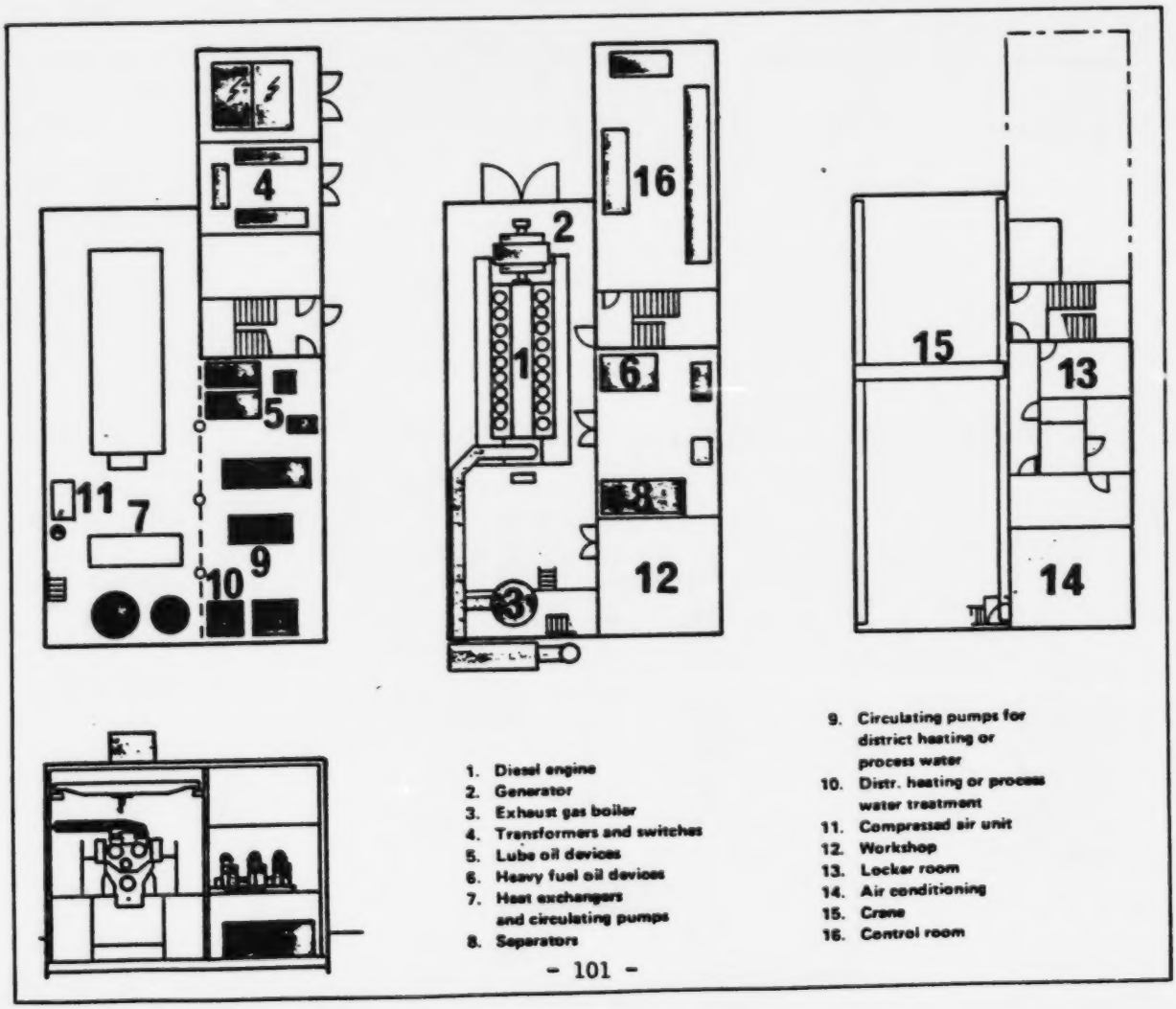
Two privately owned Finnish companies, Oy Wärtsilä Ab and A. Ahlström Oy, in close cooperation, have developed a new power plant concept, a low calorific value (LCV) gas-driven diesel power plant, which makes it possible to utilize local solid fuels for power or combined heat and power production.

Local solid fuels, especially renewable biomass fuels, are becoming more and more important sources of energy, when demand for self-sufficiency, in so far as energy is concerned, is increased. The heating value of these fuels is usually low. It is, therefore, not profitable to transport them long distances. Biomass fuels are thus locally valuable.

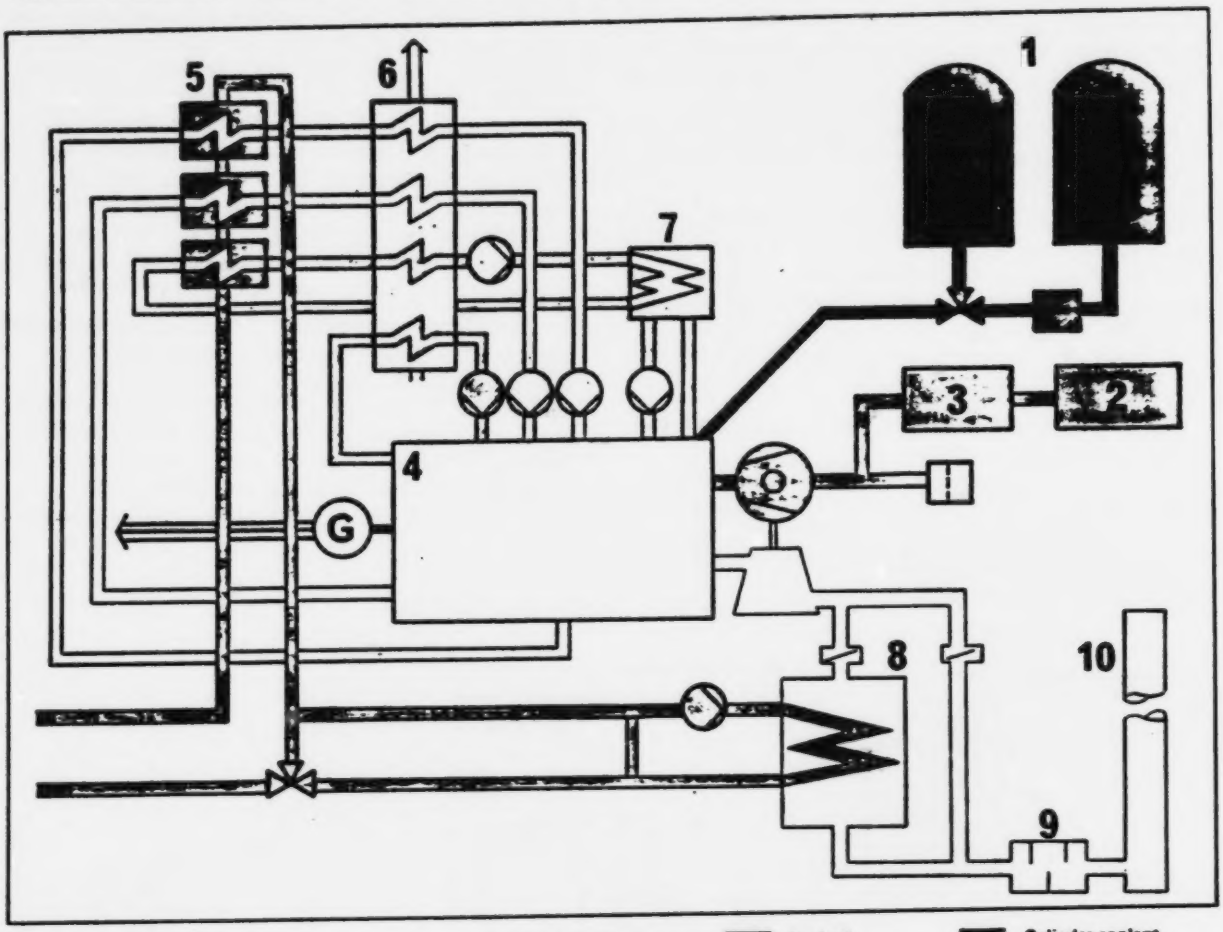
The LCV gas diesel power plant gives communes and industrial establishments the full benefit of their own local energy reserves. The energy required is obtained, refined and used in their own locality. The LCV gas diesel power plant has, in this way, both immediate and intermediate positive effects on the economic life in the locality.

In the gas-driven diesel heating and power plant, solid fuel is gasified in the Pyroflow -circulating fluidized bed gasifier. The gas given off is used as fuel for the Wärtsilä SEMT Pielstick-diesel engine. The generator, coupled to the diesel engine, produces electricity. The exhaust and cooling heat is utilized to its best advantage in process or room heating or in fresh water production. Of course, the power plant can be built for electricity production only. The diesel engine is then cooled by water (from the sea, lake or river) or by radiators or cooling tower system.

The electric output range of the LCV gas diesel power plant is 2,3–28 MW and the corresponding heat output range 2,9–35 MW. Thus the power plant is suitable for local energy production in communes and industrial establishments near which solid fuel can easily be obtained – such as peat or wood, for which the traditional steam power plant with a back pressure or extraction condensing turbine is too great.



WÄRTSILÄ SEMT PIELSTICK -DIESEL POWER PLANT

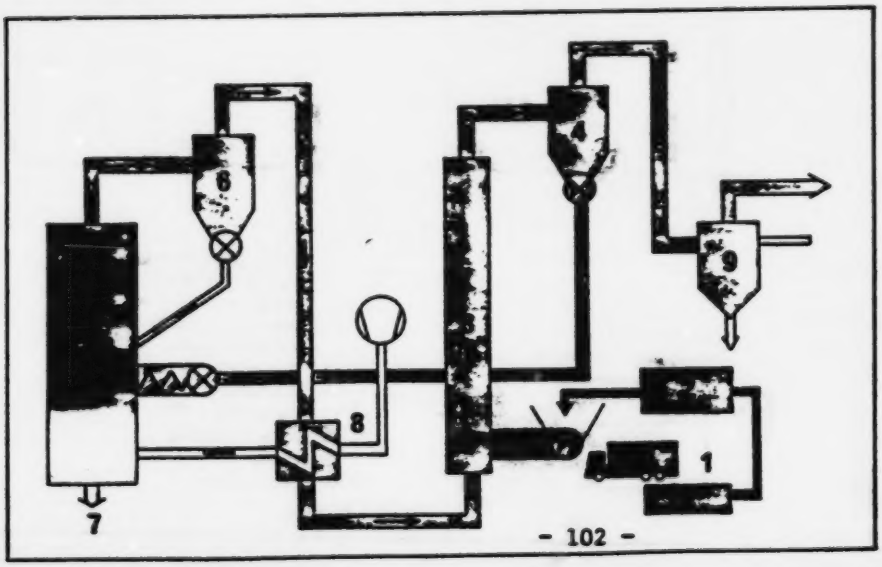


1. Fuel oil storage tanks
2. PYROFLOW -gasifier
3. Gas cleaning
4. WÄRTSILÄ SEMT PIELSTICK -diesel engine
5. Waste heat utilization
6. Auxiliary coolers
7. Lube oil cooler
8. Exhaust gas boiler
9. Silencer
10. Stack

Fuel oil
LCV gas
Exhaust gas
District heating or process water
Raw water

Cylinder coolant
Charge air coolant
Lube oil coolant
Auxiliary coolant
Lube oil

AHLSTRÖM PYROFLOW -GASIFIER



1. Intake for solid fuel
2. Solid fuel pretreatment
3. Dryer
4. Cyclone
5. Circulating fluidized bed reactor
6. Uniflow cyclone
7. Ash removal
8. Air preheater
9. Gas cleaning

Solid fuel
LCV gas
Air
Raw water

TESTED COMBINATION

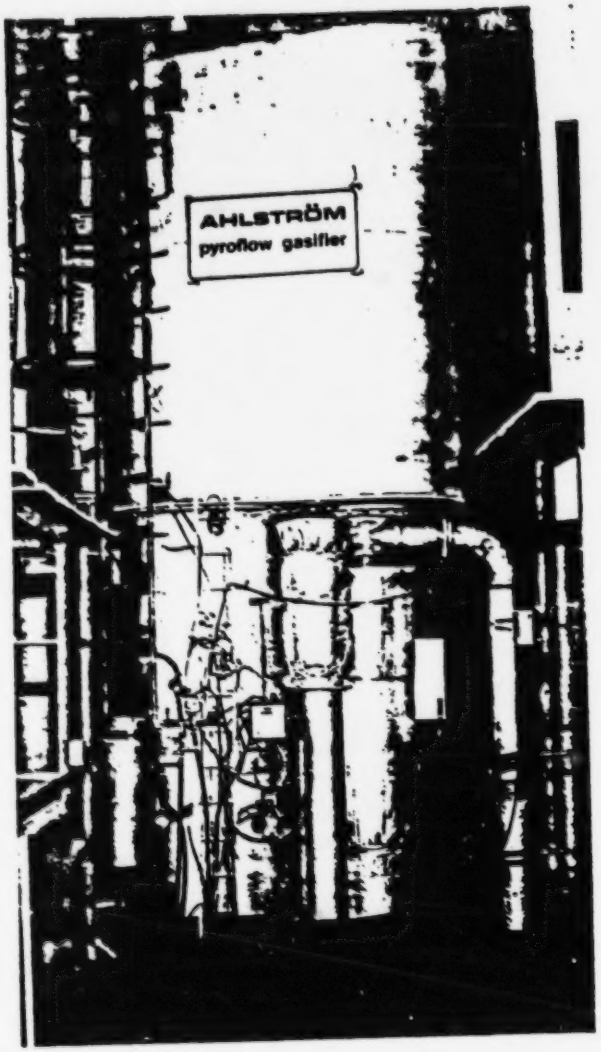
Extensive development of the LCV gas diesel power plant has been carried out during the last several years.

The aims for development were:

- to build a solid fuel utilizing gasifier with a large control range which would produce gas suitable as fuel for the turbo-charged diesel engine
- to adapt the diesel engine to use gas with a low caloric value as fuel
- to design a power plant combination available for commercial energy production.

The aims have been achieved. As a result of the development work, the combined test run of the gasifier and the diesel engine was carried out in close cooperation at the Hans Ahlström laboratory in Karhula, in the south-east of Finland, during the summer of 1982.

Because of the successful test results, the LCV gas diesel power plant is ready to be built for commercial energy production.



The upper part of the Ahlström Pyroflow-gasifier.

TESTING EQUIPMENT AND RESULTS

The gasification equipment used was formed of a peat-feeding system, a pneumatic peat dryer, a Pyroflow -gasifier and a gas cleaning device.

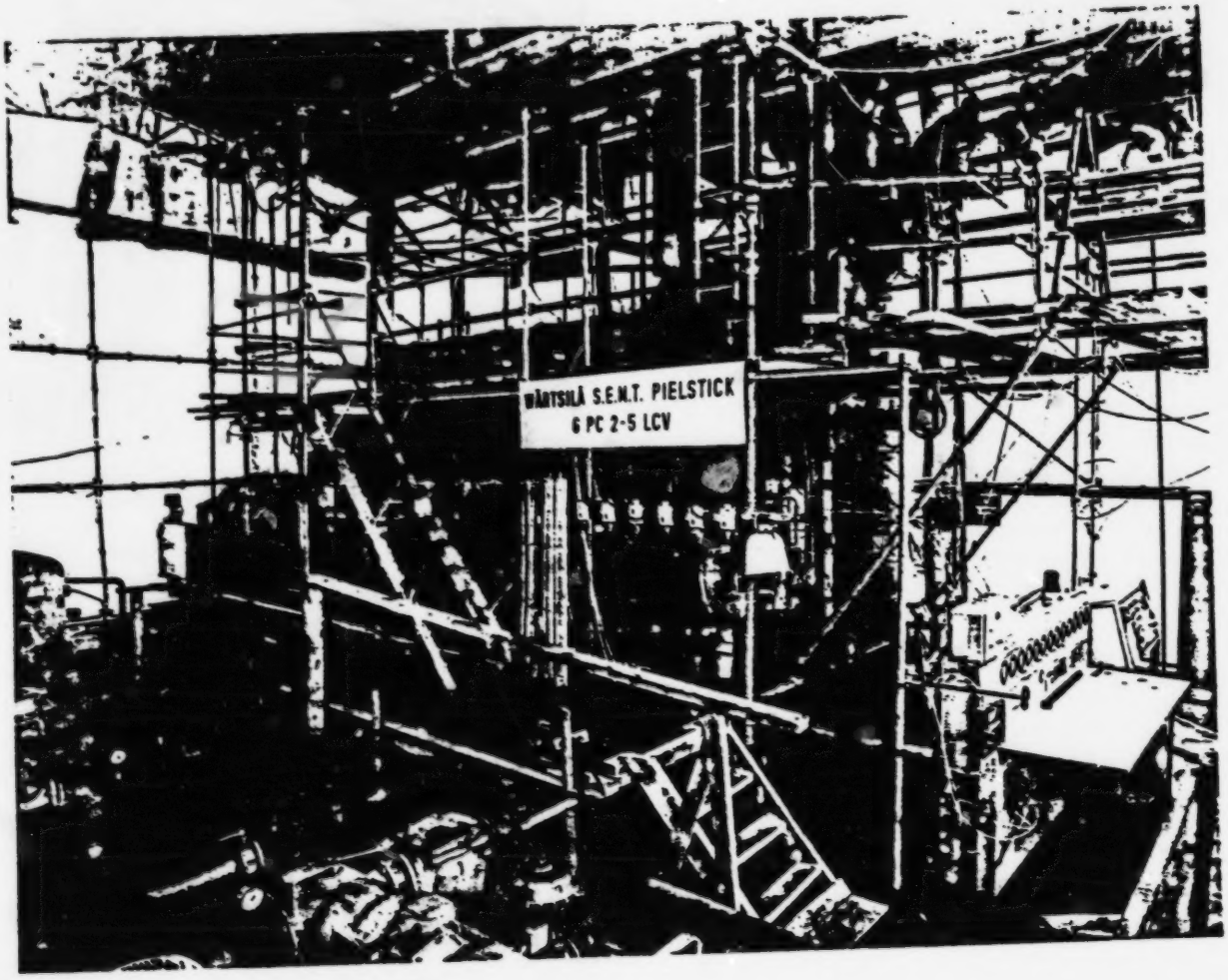
The gasification equipment had been separately tested earlier with very good results. By gasifying dry bark and wood, a gas effect of about 3 MW was achieved. The construction and function of the gasifier is a circulating fluidized bed reactor. Many solid fuel boiler plants, which based on the Pyroflow -technique, developed by A. Ahlström, are already in use.

We tried to achieve the highest possible efficiency by building, at the back of the gasifier, a flash dryer, which dries wet peat and chips with the hot (about 650–700°C) product gas, before feeding them into the gasifier.

The tested solution worked very well and proved to be safe. During the test, it was also found that by separating gasifying and drying into separate processes, the formation of tar can be noticeably reduced.

The equipment performs most efficiently when the moisture from the fuel reaching the power plant is 50–60%. This corresponds to the normal moisture of biomass fuel, which is normally used.

A Wärtsilä SEMT Pielstick 6 PC 2–5L LCV was used as the test diesel engine. This is a medium speed turbo-charged and intercooled direct injection engine. During the last few years, Pielstick has been the most widely sold medium speed heavy fuel oil engine in the world.



Wärtsilä SEMT Pielstick -diesel engine on the test bed.

The final model chosen for the testing engine is based on experience gained from using more than 20 natural gas driven dual fuel Pielstick engines over several years.
The caloric value of gas obtained from solid fuel is significantly lower than that of natural gas.
This made it necessary to find a new solution for gas feeding. In the low caloric value gas engine, the gas is mixed with the combustion air before being passed through the compressor of the turbo-charger, which feeds the mixture of gas and air through the cooler to the cylinders. In the cylinders, the compressed mixture is ignited by injecting a small amount of heavy fuel oil into the combustion chamber at the moment when the piston approaches the top dead centre.
The renewed gas feeding system, together with the other new models of the gas engine, have been tested by driving the engine on propane and natural gas. The equipment was, already then, found to function satisfactorily.

In the combined test with the gasifier, the running of the engine on a low caloric value gas was ensured and the values achieved were measured.

The chosen maximum continuous rating per cylinder, 404 kW, is based on the test results. The break mean effective pressure, showing the engine's stress value, is then 1,68 MPa (16,8 bar) and the shaft efficiency 39,5%. The values are among the world's top class for gas driven engines.

RELIABLE TECHNOLOGY

In spite of the high stress value, the low caloric value gas-driven engine will be reliable. The corresponding heavy fuel oil engine is, in fact, in so far as the most demanding parts are concerned, completely comparable to the gas engine, even though the nominal effect is 36% higher.

Because of the robust structure and pure nature of the fuel, the need to service the gas engine is less and the life of the engine is even longer than that of the heavy fuel oil engine which has proved to be reliable.

The complete power plant has, as its main components, not only the gasifier and the diesel engine, but also: Equipment for receiving and pre-treating solid fuel, electricity-producing equipment, diesel engine auxiliary equipment, heat producing system and, furthermore, control, protection and supervision equipment for the plant.

All power plant equipment is tested and has proved to be reliable technology.

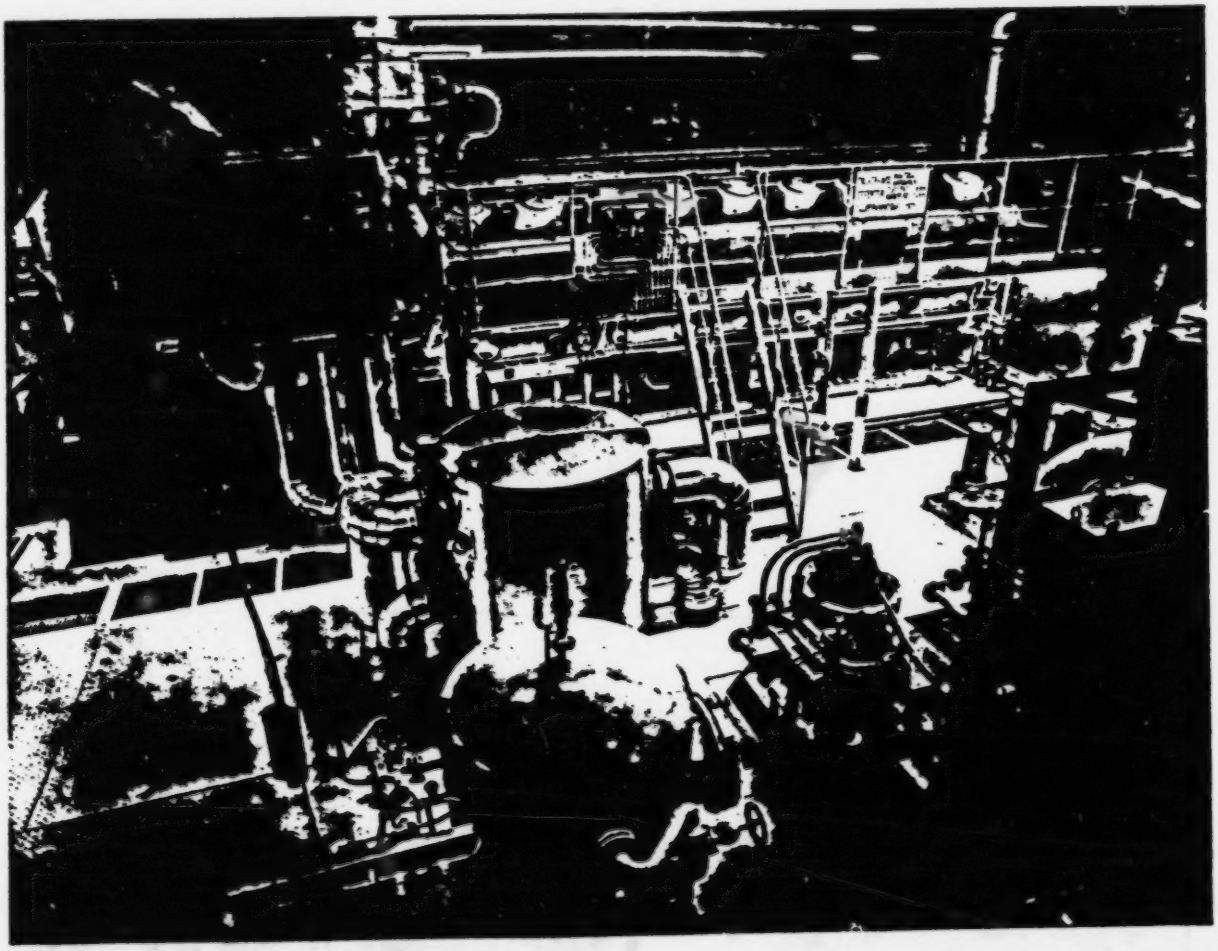
In Finland, solid fuel receiving and pre-treating equipment is very often used in district heating boiler plants which use domestic fuel.

We have had very good experience in the use of the diesel power plant electricity producing equipment and the generator, with its high voltage equipment, from the diesel heating and power plant in Mariehamn. There is a great deal of experimental material concerning the engine auxiliary equipment, which is, in principle, the same equipment as that used in every diesel powered ship.

Measured in terms of power, Oy Wärtsilä Ab has, in Turku, manufactured diesel engines to the tune of more than two million kWs.

A great deal of practical experience from heat producing-, control-, protecting- and supervision systems has been obtained from the four large diesel heating and power plants in Scandinavia.

The availability of the LCV gas diesel power plant can be guaranteed to be over 90% since the Mariehamn diesel heating and power plant has proved the technology and the very high level of availability.



The heart of the Mariehamn diesel heating and power plant: heavy fuel oil driven Wärtsilä SEMT Pielstick -diesel engine.

OUTPUTS AND INPUTS OF THE BIOMASS FUEL DRIVEN DIESEL POWER PLANTS

Diesel engines	Electric output	Thermal output	Fuel input		
			Wood (w=60%)	Peat (w=60%)	Heavy fuel oil
Type	MW	MW	MW	MW	MW
6 PC	2,3	2,9	7,0	6,9	0,4
8 PC	3,1	3,9	9,3	9,2	0,5
12 PC	4,7	5,9	14	14	0,8
14 PC	5,4	6,8	16	16	1,0
16 PC	6,2	7,8	19	18	1,1
18 PC	7,0	8,8	21	20	1,2
2 x 18 PC	14	18	42	41	2,5
4 x 18 PC	28	35	84	82	4,9

RELIABLE SERVICE

The professional diesel power plant personnel of Oy Wärtsilä Ab and the gasifier and process equipment experts of A. Ahlström Oy will be at your disposal for LCV gas diesel power plant matters right from the start of energy service planning.
A follow-up and information service will be provided, if so wished, for the whole functioning time of the power plant.
The companies guarantee a reliable and fast spare part service.

For more details, please contact us at:

A. Ahlström Osakeyhtiö
Varkaus Engineering Industry
Process Equipment Works
P.O. Box 137
SF-78201 VARKAUS 20, FINLAND
Phone • 358 72 211
Telex 4383 alpro sf

Oy Wärtsilä Ab
Turku Shipyards
Diesel Works
SF-20810 TURKU 81, FINLAND
Phone • 358 21 359500
Telex 62640 wty sf

AHLSTRÖM

WÄRTSILÄ

PRINTED IN FINLAND BY HERTEILÄ/ST OY/ESTFAIND 5649/1983 06 2000

PROFITABLE ELECTRICITY PRODUCTION

The efficiency of electricity production is high – 30–33% at full load and 25–27% at half load, dependent on the fuel and its moisture content. The energy demand of the plant itself has not been reduced. It varies as a function of the plant size and fuel moisture content and is normally 1.5–2.5% of the total fuel input.

In combined electricity- and heat production, the total efficiency of the LCV gas diesel power plant is due to its efficient utilization of heat optimum, 66–72%, having deducted the energy demand of the plant itself, and also dependent on the size of the power plant and the moisture content of the fuel.

The electricity factor of the LCV gas diesel heating and power plant, i.e. the ratio between electricity and thermal outputs, is higher than in other heating and power plants with the same effect.
Without reducing the energy demand of the plant itself, the ratio is 0.78–0.80 and, having deducted the same, is 0.74–0.76. A good ratio means a large output of electricity, which is valuable energy, in connection with a given heat demand.

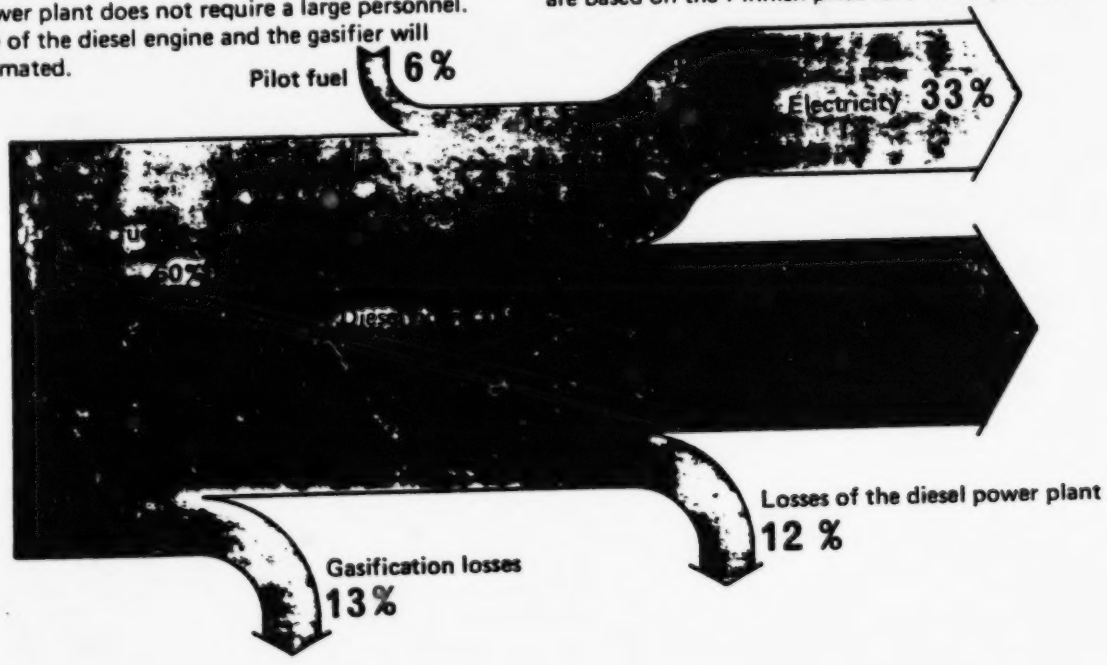
The power plant does not require a large personnel. The use of the diesel engine and the gasifier will be automated.

Continuous supervision is required for the overseeing of fuel receiving and pretreating. Necessary personnel in a power plant is:

- one master mechanic
- five (5) operators (uninterrupted three-shift supervision)
- one service man
- one electrician and a part-time cleaner

The LCV gas diesel power plant is gauged as a heavy duty power plant for a commune or industrial establishment. If there is already a heat or electricity producing function and personnel required for this work, usually these people are able to do some of the work in the gas power plant, so that the need for new personnel has to be appropriated separately for every occasion.

The other costs incurred by the LCV gas diesel power plant, when functioning, are quite low. The costs of lubricating oil for the diesel engine, servicing of the whole plant, spare parts and the treatment of waste water are about 28 FIM (1 FIM 0,19 USD) per electric megawatt hour produced. These figures are based on the Finnish price level in May 1983.



SUITABILITY FOR THE ENVIRONMENT

The LCV gas diesel power plant does not cause any environmental problems. For example, in plants which burn milled peat, dust emissions are very often expelled but gas diesel power plants do not create this because solid particles in the gasifier's product gas are washed away before feeding gas to the diesel engine.

The main fuel of the engine is pure gas, so the solid particle content in exhaust gas is very low and is less than 100 mg per m^3 (0°C, 100 kPa).

The power plant building effectively prevents noise caused by the engine from reaching the environment. Thus, the power plant can be situated quite near residential areas. Even though the fuel treatment plant is situated outside the power plant building, the noise from the power plant does not exceed 50 dB (A) at a distance of 100 meters from the power plant.

APPENDIX II

BIBLIOGRAPHY

ENERGY ALTERNATIVES - DESCHAMBAULT LAKE, Sask.

1. Remote Saskatchewan Community Energy Overview Study for E.M.R. by:
   Underwood McLellan Ltd.
   Eneraction Resources Inc.
   March 1983

2. Northern Saskatchewan Community Directory
   Dept. of Northern Saskatchewan
   1981

3. The Social, Environmental and Resource Impact of Wood Gasification on Isolated Northern Communities, Part One and Part Two
   For: Sask. Power Corporation
   by The Institute for Northern Studies
   University of Saskatchewan
   Jan. 1980

4. Environmental Overview for the Proposed Hydro-Electric Development on the Rapid River
   For: Sask. Power Corporation
   by The Saskatchewan Research Council
   Sept. 1979

5. Cost of Harvesting Aspen Stands for Energy Production
   For: The Enfor Project
   by The Coban Institute
   Sept. 1981

6. Evaluation of the Potential of Peat in Ontario
   For: The Ontario Ministry of Natural Resources
   by Monenco Ontario Ltd.
   1981

7. Buffalo Narrows Peat Fuel Demonstration Project
   For: Saskatchewan Energy & Mines
   by Saskmont Engineering
   A Monenco Company